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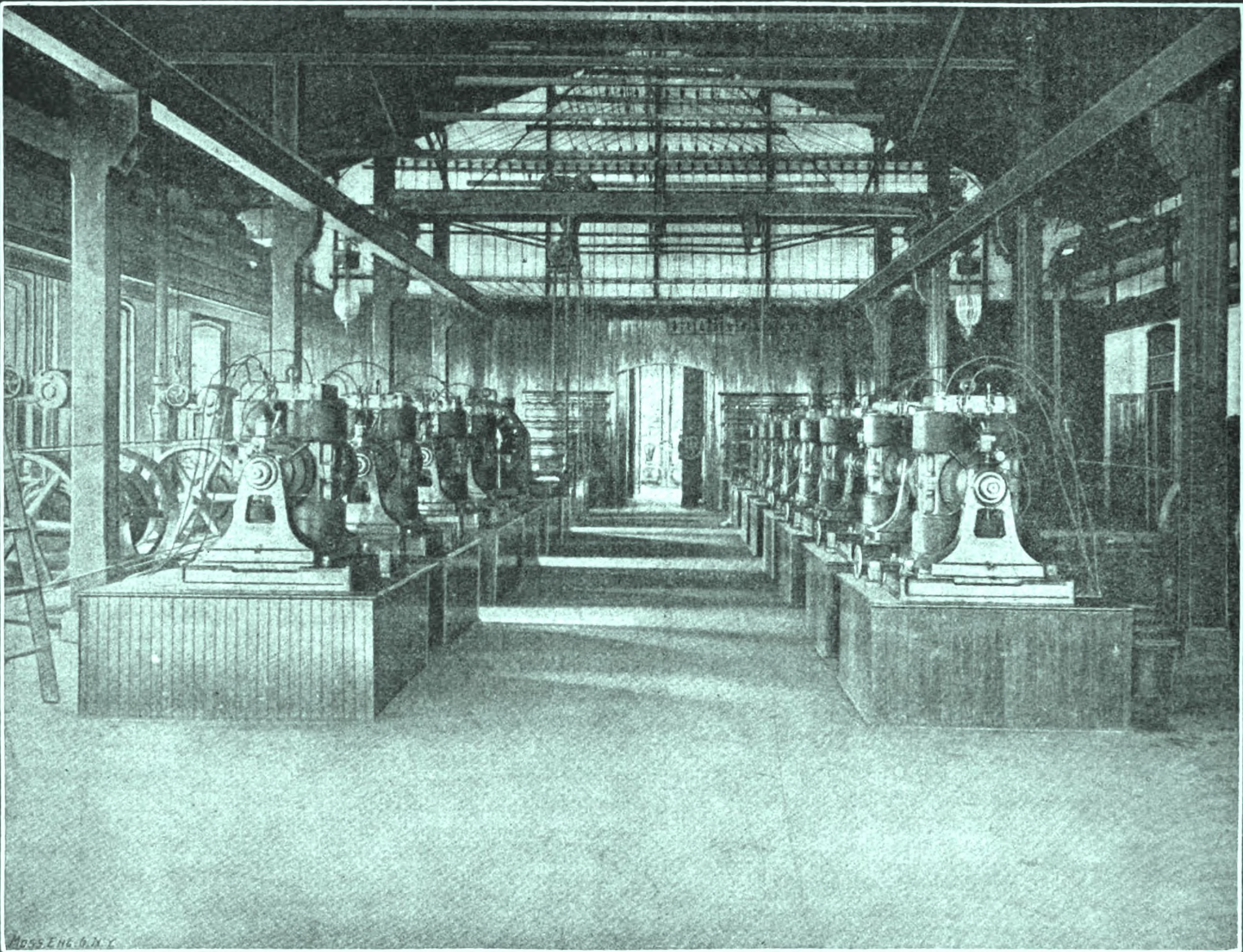

Electrical engineer

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Electrical Engineer.

A Weekly Review

OF

Theoretical and Applied Electricity.

VOLUME IX.—1890.

(January to June.)

NEW YORK:
The Electrical Engineer,
150 Broadway.

Alphabetical Index of Contents.

E denotes Editorials. **A** denotes Articles. ***A** denotes Illustrated Articles. **Ax** denotes Abstracts and Extracts.
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THE
ELECTRICAL ENGINEER.

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ELECTRICAL ENGINEER.

Conducted by F. L. POPE AND G. M. PHELPS.

PUBLISHED MONTHLY AT

150 Broadway, New York City.

TERMS OF SUBSCRIPTION.

United States and Canada,	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.30

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

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VOL. IX. NEW YORK, JANUARY, 1890. No. 97

THE ELECTRIC LIGHT IN NEW YORK, JANUARY 1, 1890.

ON New Year's night perhaps one-tenth of the seven or eight thousand arc lamps in New York were in use; the rest were dangling uselessly in streets and stores whose darkness was feebly relieved by occasional gas jets; and this not the result of accident or mishap, but of two weeks' work by a corps of axemen, set upon the poles and wires by the municipal authorities. Yet the United States was the birthplace of commercial electric lighting, and New York claims to be the industrial, commercial and social capital of America. The wit of man could hardly invent a more grotesquely absurd situation. But it has come about by no invention or contrivance; it is simply a natural consummation of vicious methods of municipal government on the one hand and vicious methods of conducting a new industry on the other hand: the crisis has been reached in New York, rather than elsewhere, simply because New York *is* the industrial, commercial and social centre of the United States, and gives, therefore, the freeest scope for both the best and the worst American tendencies. The stress has come here, and so has the break. Nowhere else was there such a field for electric lighting. It was immediately occupied; lines, good, bad and indifferent—of the latter two classes for the most part—were hastily run in every direction, till with the telegraph and telephone lines they so filled the streets of the city that a hue and cry arose to "bury the wires." This was the politicians' opportunity. The outcome was the Subway Commission, afterward the Board of Electrical Control; wherein, to quote our own words, "a political hack, a theatre agent and a presumptuous young attorney were given charge of providing a great city—far exceeding all other cities in the scope and magnitude of its electric service—with a proper system of electric conductors." Given such a condition of the electric lines as prevailed three or four years ago and such a board of commissioners as were appointed to deal with it, and the last state of the city was sure to be worse than the first. The history of the board's activities and inactivities, its doings, undoings and not-doings, is a mere weariness. Every one competent to understand the situation saw that the greater portion of the electric light conductors must remain above ground for years. The electric lighting companies soon got the measure of the commissioners, and not only kept their old and defective lines in operation, but went on building more, largely of the same flimsy construction and poor or no insulation, till at the beginning of the axemen's campaign, two weeks ago, there were several times as many miles of electric light wires overhead as there were when the legislature created a commission to put all wires underground forthwith. Excepting the low tension lines of the Edison company, laid by the company itself in its own way, no electric light conductors worth mentioning have been put underground and successfully operated in New York.

Until a year ago the Board of Electrical Control made no serious attempt to have existing overhead lines put in safe condition nor to prescribe rules for the proper construction and insulation of the numerous new lines constantly building. Then, when they undertook to apply the fairly adequate rules and regulations for overhead electric light wires, prepared by Dr. Wheeler, and notified the lighting companies of their violations of the rules, the companies gave little heed, and it was found that the Board of Electrical Control had no power to enforce its rules, and could only invoke the commands of the Mayor and the services of the Department of Public Works for the removal of lines defective under the rules and regulations. Now it is almost certain that a very little judicious chopping down of poles and cutting of wires last winter by the city authorities would have impelled the companies to such a general overhauling and improvement of their lines as would have prevented the recent series of fatalities, and would thus have precluded the wholesale and passionate onslaught of the past fortnight. The one pressing necessity was to make the overhead wires safe, an entirely feasible thing to accomplish, though troublesome and somewhat costly. But if either the authorities or the public ever had any faith in the competency of the Board of Electrical Control it had been dissipated by that body's ridiculous career; so its rules and regulations, together with its efforts to enforce them through the Department of Public Works, went unheeded till October last, when under the pressure of newspaper and popular clamor, the Mayor gave orders to the Commissioner of Public Works to remove from the streets such wires as were not safe under the rules of the board, only to be checked before the work had begun by the injunction of Judge Andrews in behalf of the lighting companies. A further series of fatal accidents from the wires followed in quick succession, continuing till the Supreme Court set aside the injunction; whereupon the axemen of the Department of Public Works were let loose. They have done their work under the guidance of inspectors of the Board of Electrical Control, and have now taken down about one-fourth of the mileage of electric light wires in the city. As the demolition included, in many cases, condemned portions only of long circuits, the result is to stop the service of about nine-tenths of all the arc lights in the city. In the opinion of the expert of the board, Dr. Wheeler, a condition of public safety has now been reached and he has advised a halt, which, we understand, has been ordered. Thus this city has accomplished the feat, after four years trial, of regulating a great industry and public service by destroying it.

What for the future? Arc lighting cannot be indefinitely suspended in New York. For public thoroughfares and many interiors it has become practically a necessity. It has never been shown that a general underground distribution by any system yet tried here can be conducted with greater safety to life than by a properly constructed overhead system. The numerous fatal accidents of the last few months are due to defects in lines or apparatus, remediable by the application of sound principles in the laying out, construction and insulation of lines, and of proper safeguards to apparatus and lamps. The neglect of such principles and safeguards has brought forth its fruit of disaster in such large measure here, rather than elsewhere, because of a great accumulation of lighting circuits in close proximity to each other and to a network of other electric wires, with the consequent liability of contact between neighboring conductors, for the most part poorly insulated, and nearly always devoid of an adequate protection, outside the insulation, against abrasion.

That the entire electric service of the city will ultimately be distributed underground we have no doubt—not for considerations of safety to life and property, but for considerations of public convenience and taste, and, in a long look ahead, considerations of economy—but no subway methods yet undertaken will, in our judgment, achieve that result. Any system adequate to the purpose has, in large part, yet to be devised, and, when devised and approved by trial, many years must elapse before it can be comprehensively applied.

Meantime the city must have its electric lighting. The present deadlock calls for a fresh start. Obviously the indispensable preliminary is to get rid of Messrs. Hess, Moss and Gibbens, permitting those worthies to resume their regular and more appropriate vocations. Public opinion, as well as the recent Grand Jury of the city will thank the legislature for so much as a beginning. If they then give us a board or commission composed in part of electrical engineers of unquestioned ability and repute, and, for the rest, of prominent citizens of administrative skill, and interested less in local politics than in the welfare of the city, giving them authority and power to regulate the existing electric service and to devise or select an adequate system of electric lines for the future, there will be some prospect of redeeming the present disgraceful situation, and much hope for the years to come. The past four years will not then have been altogether wasted.

THE ELECTRIC LIGHT CONVENTION IN FEBRUARY.

The Annual Meeting and Eleventh Convention of the National Electric Light Association will be held at Kansas City, February 11–14. One day more than usual is assigned to the meeting in view of the important topics to be dealt with and the extensive programme of papers to be read. The sound of the last fall of the gavel at the Niagara Falls convention last summer had not died away before Mr. E. R. Weeks, the president of the association, had begun preparations for the February meeting. With what assiduity and with what success he has worked, with the co-operation of the secretary and executive committee, can be seen in the programme for the forthcoming convention, printed elsewhere in this issue.

It is to be counted a distinct gain and advance in the scope of the association's proceedings that a distinctively scientific electrician, Professor Henry A. Rowland, has engaged to make an address in which he will treat practical difficulties from the point of view of the most advanced knowledge.

Another striking feature of the convention will be found in papers to be read by Professor Elihu Thomson and Mr. F. J. Sprague, and an address from Mr. T. A. Edison by phonograph. Mr. Weeks and the association are to be congratulated upon securing the co-operation of men of such technical eminence. Other papers, on technical and administrative subjects, entrusted to competent hands, together with reports of committees upon some of the most important and pressing questions touching electric light and power interests, make up a programme that should attract to Kansas City a larger gathering than any previous convention has shown.

The assembling of the association at Kansas City may be expected to bring out a larger interest in its work than heretofore among electric light men west of the Mississippi, and to induce a considerable accession to its membership.

Through the careful forethought of Mr. Weeks and the open-handed public spirit of Kansas City, the most ample and convenient accommodations for the sessions of the convention and for the accompanying electrical exhibits have been secured.

A LAWYER'S VIEW OF THE EDISON DECISION IN CANADA.

In a private note to the editor of the Electrical Engineer, a distinguished New York lawyer, who has been counsel in a number of the most important patent cases of recent years, referring to the decision of Deputy-Commissioner of Patents, Pope, of Canada, in February last, annulling the Edison lamp patent, and the reversal of that judgment on re-hearing by the Commissioner and the Minister of Justice, in November, remarks:—

> The interpretation put by Mr. Pope upon the facts was entirely destructive of all conservative principles of jurisprudence: and a short series of such decisions would unsettle all established things. I never saw a stronger instance of the inefficiency of a lay mind for dealing with topics whose significance the trained faculty easily perceives.
>
> There is the electrician's instinct, and the lawyer's instinct, which are like additional faculties—additional to the limited list given by nature to the rest of us. Just so medical evidence is quite different from legal evidence; and I suppose that most lawyers would be unable to feel the intuitive or reasoning process by which the physician or physicist reach sound judgments in their specialty.

In the Kemmler case the Supreme Court, General Term, finding the electrical execution law not repugnant to the constitution of the State of New York, has dismissed the writ of habeas corpus, and at last the sentimental philanthropists and officious medico-legalists who concocted and promoted the scheme will have the pleasure of seeing it put into operation.

A scientific observer of the recent tests of the electrical outfit at Sing Sing is reported to have said that to set up such elaborate machinery to kill a man was "like putting up a saw-mill to rip a match."

ARTICLES.

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS TOGETHER WITH AN IMPROVED METHOD OF TESTING.

BY WM. L. PUFFER.

SINCE the appearance of the report of the Franklin Institute on incandescent lamps in 1885, there have been no published measurements either of the efficiency or of the distribution of light about the best-known lamps now in the market. But the market lamps of to-day are much better than those of 1885, so much so in fact, that the Franklin Institute data, although very valuable as showing the state of the art in 1885 are of no especial value for use with the lamps now manufactured.

The following data and curves have been calculated and plotted from the observations made by Messrs. Walter G. Whitmore and Edwin R. Pearson, class of 1887, Massachusetts Institute of Technology, who took as the subject of their graduating thesis "A Study of the Efficiency of Incandescent Lamps." The method used is substantially like that of the Franklin Institute, but I have changed and improved the method of plotting so that the five plots tell the distribution of light, shape of filament and its position in regard to photometer, etc. This method of testing lamps is in regular use in the laboratory with very satisfactory results.

The standard of light used is a Methven screen which has been standardized by comparison with many standard candles at different times and by different observers, and also with a Harcourt standard burner. The mean of a large number of observations agrees so closely with the maker's value of two candles that this is assumed to be right within the limits of error of the photometer, and no correction is used.

The photometer is a modified Bunsen, 100 inches long, graduated into inches and tenths by a dividing engine, and having also a scale of "ratios" which when multiplied by the candle-power of the standard give candle-powers directly. Both the standard burner and the lamp under test are thoroughly screened so that little if any diffused light reaches the eye of the observer. A key near the observer's hand and a lamp overhead furnish light when needed for reading.

The lamp-holder is quite different from that used by the Franklin Institute, and will hold any of the lamps now in the market without danger of straining. The socket with lamp under test is screwed on the end of a brass rod, which is free to slide or rotate in a sleeve fixed in the centre of and perpendicular to a disc of brass. Set screws are provided for clamping the rod in the sleeve. The disc is arranged on the bottom of a U-shaped strap in such a position that it can be turned while the rod always remains parallel to the sides of the U and in the same plane. The disc has notches every five degrees, and the strap carries a locking pawl, which also serves as an index.

The U-shaped strap is pivoted near the top in a frame so as to have rotation about a horizontal axis; it also has a notched disc, and the frame a pawl and index. One arm of the U is longer than the other, and carries a movable counterweight.

This apparatus is set with the horizontal axis perpendicular to the line of the photometer and on a level with the centre of the greased disc; the vertical circle being adjusted to read 0° when the lamp stands vertical with the socket underneath, then the horizontal disc is placed at 0° and the rod carrying the lamp moved till the plane of the shanks is perpendicular to the line of the photometer and the horizontal axis cuts the filament midway of its length. This position of the lamp is called the "standard position," and the photometer reading for this position, the "standard reading." By means of the horizontal circle, any desired degree of longitude can be instantly turned towards the photometer and by the vertical circle any degree of latitude. Flexible wires connected directly to the socket are used for current leads, and another set is used for measuring the potential at the lamp terminals. It is assumed that the socket and the lamp terminals will be of the same potential, except with very low resistance lamps, or with lamps requiring a large current.

Electrical measurements were made by a set of carefully calibrated Thomson's current and potential galvanometers, placed in a room free from magnetic disturbances, where the value of the earth's component had been determined. As the current taken by the potential galvanometer bears a very sensible ratio to that in the lamp, the instrument is always kept in circuit and a correction is made for the current passing through it. An adjustable resistance in the lamp circuit enabled the observer to keep the potential at the right amount. The potential galvanometer used was adjusted for Rayleigh volts, and as the difference between this and Legal volts is nearly within the limits of accuracy of the instrument no correction for reduction to the latter was made. It was assumed that the voltage marked on the lamps was in Legal volts, and that if the lamp changed its resistance while under test the volts must remain constant and the current and candle-power allowed to vary. If any lamps were marked in terms of the B. A. volts, then they were tested at too high a voltage.

When the lamp had been placed in the "standard position" and the potential adjusted, candle-power readings were taken at 65 different positions; the value used for each position being the mean of three or four settings of the disc according to the method used by the observer.

The standard direction to which all others are referred, is a line perpendicular to the plane of the shanks of the filament and lying in the equator of the lamp. By equator is understood the line cut upon the glass globe of the lamp, when upright, by a horizontal plane half way up the filament. *Zero point or* 0° is the starting point for measuring the angular rotation of the lamp and is at the intersection of the standard direction and the equator.

Horizontal distribution is measured by candle-power readings at each 30° around the equator beginning and ending with 0° or the "standard direction." Of these 13 c. p. readings, the first and last should, of course, check.

Mean horizontal candle-power is the mean of the first 12 of these readings, the check reading being omitted.

Vertical distribution is measured on each of four complete meridians, *i. e.*, those of 0°, 45°, 90°, 135° on the equator. On each of these four circles candle-power readings are taken at every 30° (of latitude), beginning and ending with 0°, thus giving 13 readings, the first and last of which should check.

Standard reading is the mean of all readings in the direction of the zero point ("standard position"). It is an arbitrary position selected for convenience. By it and the "reduction factors" the candle-power (spherical or horizontal) may be determined under any given potential or current at any subsequent time by one reading. Great care should be taken in placing a lamp in this position, because in some lamps a very slight error would make a very considerable difference in the candle-power, and of course in the "factors." When a number of tests are to be made on any one type of lamp it is preferable to select a point on the horizontal circle in that part of the curve where the rate of change of candle-power is very small, and so avoid error due to hasty or imperfect setting of the lamp for the standard reading.

Mean spherical candle-power is computed from 38 readings selected from those described, with the aim of obtaining the average intensity of light in all directions. These readings are as follows :—

Mean of 4 north pole readings (long. 0°, 45°, 90°, 135°) counts 1
Longitude 0°, Latitude 60°, 120°, 240°, 300°, giving 4
" 90°, " 60°, 120°, 240°, 300°, " 4
" 0°, " 30°, 150°, 210°, 330°, " 4
" 45°, " 30°, 150°, 210°, 330°, " 4
" 90°, " 30°, 150°, 210°, 330°, " 4
" 135°, " 30°, 150°, 210°, 330°, " 4
Equator, 12 readings (or mean horizontal × 12) counts 12
South pole reading assumed zero and counts 1

Total 38

The values for these positions are selected, added and divided by 38.

Horizontal reduction factor is the mean horizontal candle-power divided by the standard reading.

Spherical reduction factor is the mean spherical candle-power divided by the standard reading.

The mean spherical candle-power divided by the mean horizontal candle-power gives a very useful factor which is not so much affected as the two above by a slight error in setting the lamp in the exact standard position. Inspection of the curve for the 70-volt Weston lamp will show that a very slight error would materially change both the horizontal and the spherical reduction factors, but would not alter the ratio of the two. Obviously the product of the standard reading taken at any time, and the reduction factors will give the horizontal or spherical candle-power without any other measurements.

The method of plotting the results of a test on a lamp is thought to be an improvement on the Franklin Institute method, and is designed to show at a glance,—

1. The distribution of light in five great circles. 2. The relative position of the lamp filament to the photometer at the zero of each circle. 3. The appearance of the filament as seen from the photometer disc at the zero of each circle. 4. The rated candle-power. 5. The mean spherical candle-power. 6. The mean horizontal candle-power. 7. A table of data.

For example, take the 70-volt Weston lamp. This lamp has a zig-zag filament of rectangular section twisted when mounted, which gives a very characteristic set of distribution curves.

On the horizontal plot we see the photometer bar represented by the black line on the left, and in the centre is the horizontal projection of the filament at the zero position, "with the plane of the shanks perpendicular to the line of the photometer bar" and also a drawing of the filament as seen from the photometer disc at the zero of the circle. The curve shows that the light is greatest at about 150° and 330°, and weakest at about 60° and 240°; now, according to the Philadelphia method, we could not tell why this is so, but a glance at the projected filament (and also the pictures of the filament seen at 0°, 45°, 90°, 135°) shows that in one case the sides and in the other the edges of the corrugations correspond with the highest and lowest photometer readings. This plot also shows that the mean spherical candle-power is nearly equal to the mean horizontal, but that neither are up to the rating of 16 c. p. under any reasonable assumption that can be made as to the meaning of that term. The observed candle-powers are indicated by the figures written near the intersection of the curve and the radii drawn 30° apart.

The next plot shows the distribution of light in a vertical plane passing through the zero of the horizontal circle. As before, the horizontal projection of the filament is seen in its position relative to the photometer bar at the zero of the circle, and a drawing of the filament as seen from the photometer at the zero position.

The next plot shows the distribution in a vertical plane passing through 45° on the horizontal circle. The projection of the filament shows that the divided plate and lamp was turned 45° right-handedly, thus bringing the 45° position on the horizontal plot towards the photometer. The diminished amount of light is due, as indicated by the sketch of the filament, to the presentation of the edges of the carbon to the photometer. The next two plots are taken in a similar way at 90° and 135° respectively on the horizontal circle.

The pictures of the filament were obtained by holding the lamp behind a plate of glass and before a bright lamp and tracing the shadow of the filament. The scale of plotting is, unless otherwise stated, 0.1 inch per candle, and the filaments are drawn "life size."

All of these lamps were bought in the winter of 1886–87 of supply companies in Boston, out of stock, and presumably could not in any way be picked lamps.

The Edison lamps had the copper-plated shanks, and are now (1889) known as the "old lamp." The Weston 110-volt lamp is not now in the market, and I believe was on sale for only a short time after these were bought, an improved lamp taking its place. I do not know whether the 70-volt Weston lamp of the kind tested is in the market or not. The Thomson-Houston and Swan lamps appear similar to those now in the market, and are, as far as I know, the same.

(*To be continued.*)

Results Calculated from the Observations of Messrs. Whitmore and Pearson, Class of '87, by Wm. L. Puffer.

Lamp—1887-8.	Mean standard reading.	Mean spherical c. p.	Spherical reduction factor.	Mean horizont'l c. p.	Horiz. reduction factor.	Spher. ÷ horizont'l	Volts.	Amperes.	Watts.	Watts per spherical c. p.	Watts per hor. c. p.	Lamps per e. h. p.	Mean spher. cand. per e. h. p.	Mean hor. can. per e. h. p.
Weston 70 volt. 16 c. p.	16.63	14.25	0.857	15.13	0.909	0.942	69.96	1.021	71.43	5.01	4.72	10.4	149.	158.
Weston 110 volt. 16 c. p.	8.97	10.96	1.222	13.37	1.491	0.820	110.1	0.530	58.36	5.82	4.36	12.8	140.	171.
Thomson-Houston 52.6 volt. 20 c.p.	21.00	16.82	0.801	20.68	0.985	0.813	52.61	1.250	65.76	3.91	3.18	11.3	191.	235.
Thomson-Houston 75 volt. 16 c. p.	16.00	13.31	0.832	16.18	1.011	0.823	74.98	0.705	52.87	3.97	3.27	14.1	188.	228.
Thomson-Houston 110 volt. 16 c. p.	13.00	10.50	0.808	12.86	0.990	0.816	100.1	0.472	51.96	4.95	4.04	14.4	151.	185.
Edison 101 volt. 10 c. p.	10.50	8.25	0.786	10.38	0.987	0.795	100.9	0.512	51.65	6.26	4.98	14.4	119.	150.
Edison 101 volt. 16 c. p.	13.00	13.25	1.020	16.46	1.27	0.805	100.9	0.789	79.58	6.00	4.84	9.4	124.	154.
Edison 101 volt. 32 c. p.	26.53	28.59	1.078	34.21	1.290	0.836	100.9	1.295	130.7	4.57	3.82	5.7	163.	195.
Swan 36 volt. 8 c. p.	8.09	6.61	0.817	7.76	0.959	0.852	35.96	0.786	28.26	4.27	3.64	26.4	175.	205.
Swan 38 volt. 16 c. p.	13.10	10.57	0.807	12.25	0.937	0.863	38.05	1.300	49.65	4.70	4.05	15.0	179.	208.
Swan 46 volt. 8 c. p.	7.39	5.89	0.797	6.70	0.907	0.879	45.99	0.534	24.56	4.17	3.67	30.4	210.	244.
Swan 46 volt. 16 c. p.	15.54	14.38	0.925	16.73	1.077	0.859	45.99	1.113	51.18	3.56	3.06	14.6	141.	177.
Swan 92 volt. 10 c. p.	8.88	7.17	0.807	9.03	1.027	0.794	91.98	0.413	38.00	5.30	4.21	19.6	157.	191.
Swan 92 volt. 16 c. p.	15.30	11.49	0.751	14.00	0.915	0.821	91.98	0.594	54.64	4.76	3.90	13.7	185.	217.
Swan 92 volt. 32 c. p.	33.57	27.74	0.826	32.48	0:968	0.854	91.98	1.215	111.8	4.03	3.44	6.7	159.	184.

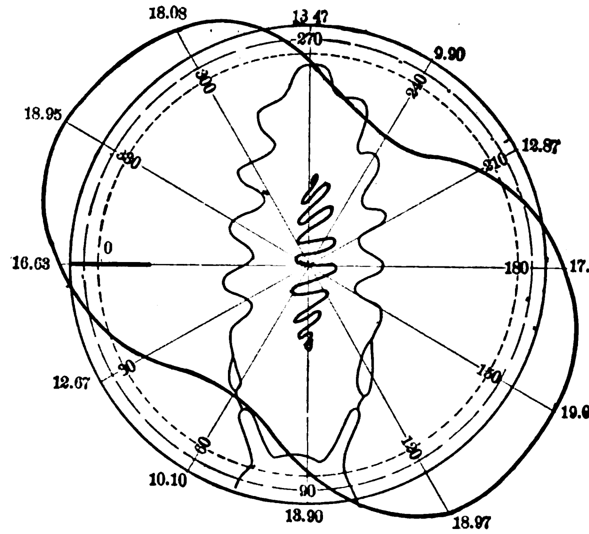
DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE I.

Lamp.—Weston, 70 volt. 16 c. p.
Mean standard reading — 16.63.
Mean spherical c. p. — 14.25.
Spherical reduction factor — 0.857.
Mean horizontal c. p. — 15.13.
Horizontal reduction factor — 0.909.
Mean sph. c. p. + Mean hor. c. p. — 0.942.
Volts. — 69.96.
Amperes — 1.021.
Watts — 71.43.
Watts per mean sph. c. p. — 5.01.
Watts per mean hor. c. p. — 4.72.
Rated c. p. — full circle.
Mean sph. c. p. — dotted circle.
Mean hor. c. p. — dashed circle.
Section of filament — —
Scale, 10 c. p. per inch.

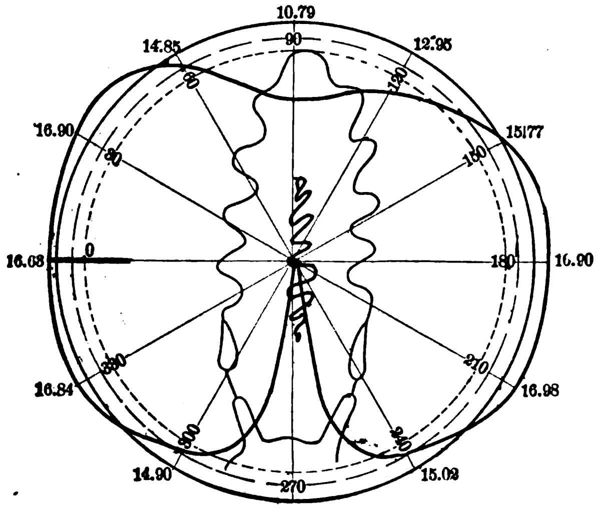
W. L. P.

Full circle reduced from 3.2″ to 2.5″ in engraving.

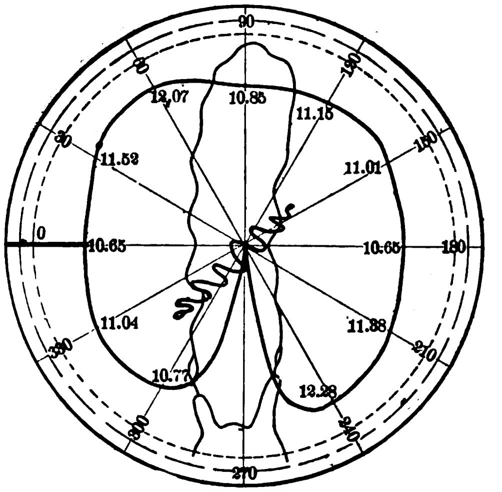
HORIZONTAD



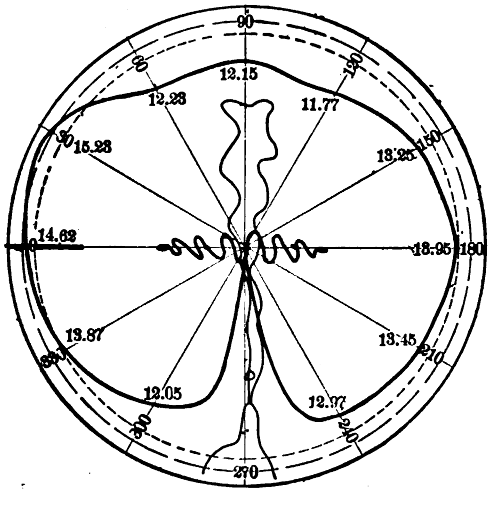
VERTICAL 0°



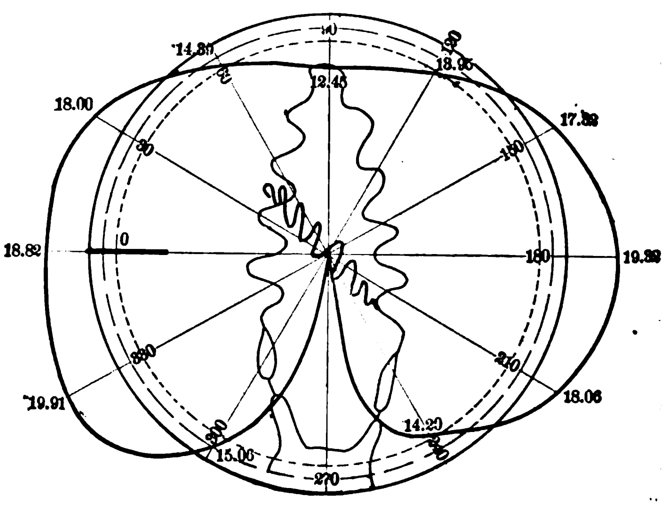
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°



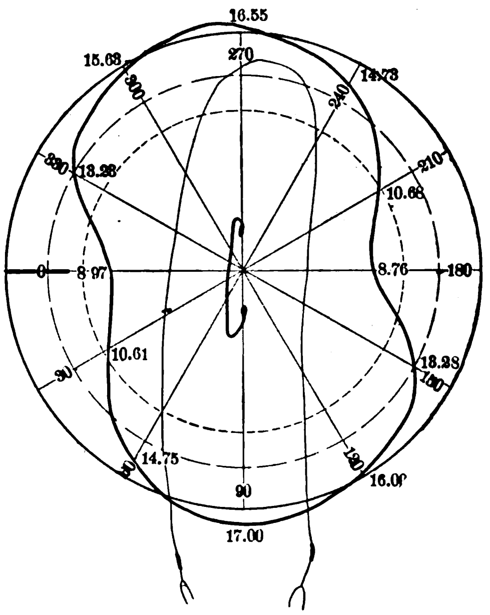
DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE II.

Lamp.—Weston, 110 volt. 16 c. p.
Mean standard reading = 8.97.
Mean spherical c. p. = 10.96.
Spherical reduction factor = 1.222.
Mean horizontal c. p. = 13.37.
Horizontal reduction factor = 1.491.
Mean sph. c. p. ÷ Mean hor. c. p. = 0.820.
Volts. = 110.1.
Amperes = 0.530.
Watts = 58.36.
Watts per mean sph. c. p. = 5.32.
Watts per mean hor. c. p. = 4.36.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = ▬
Scale, 10 c. p. per inch.

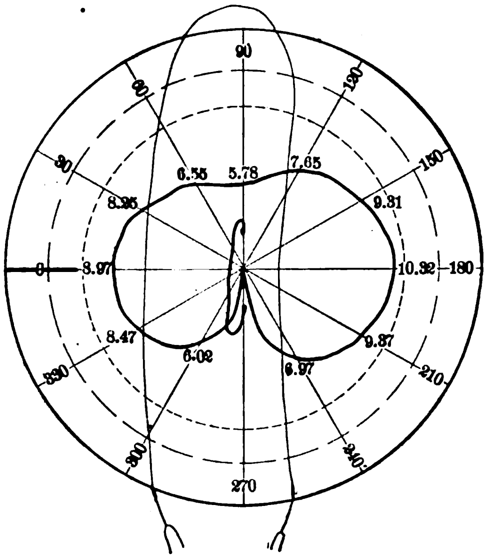
W. L. P.

Full circle reduced from 3.2" to 2.5" in engraving.

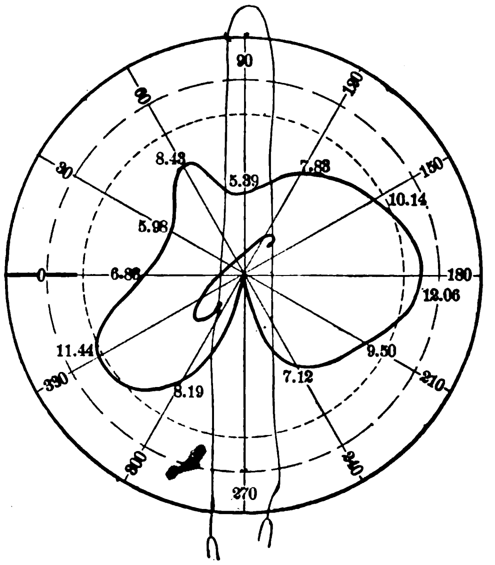
HORIZONTAL



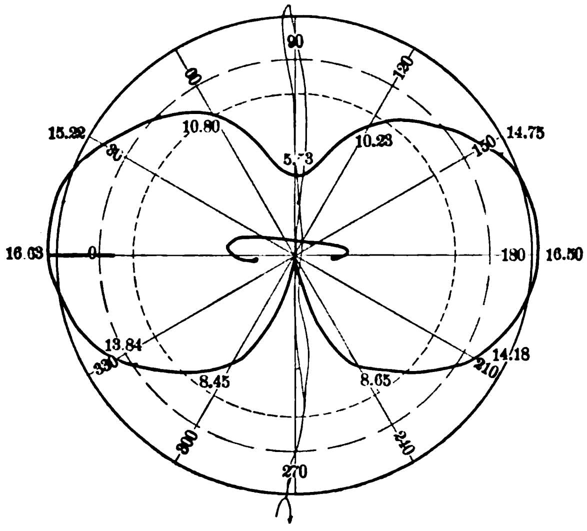
VERTICAL 0°



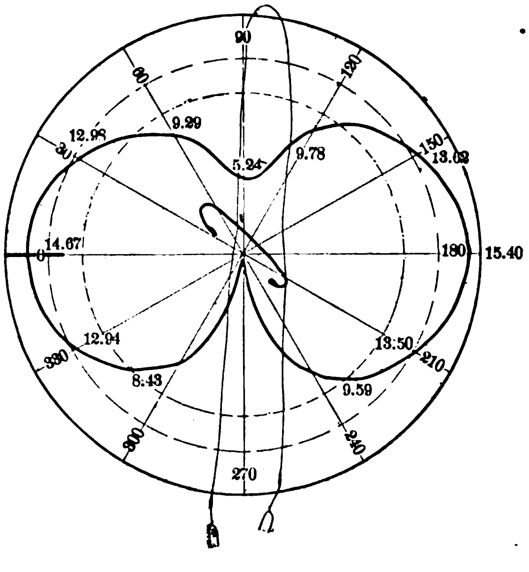
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°



TRANSFORMERS.[1]

BY HARRIS J. RYAN.

The apparatus by means of which electrical energy of one form may be transformed to that of any other form, few engineers fail to appreciate.

So great have been the anticipated possibilities offered by the application of the modern transformer of alternate current energy that in most cases in our country especially has the transformer found immediate application, with but little thought or study of its exact performance. Much experimental work has been done by trial methods to the end that our manufacturers are able to supply transformers that answer for much that is desired practically with a commercial efficiency that can be made higher than is probably possible by any other transformer of energy.

In electrical engineering, as well as other branches of engineering for the broad application of one method or another, it is always of the highest importance that the cause and extent of every effect is thoroughly understood. with regard to the mutual action and interaction of all forces and materials in relation to themselves, or to energy of one form or another.

It was with a view of obtaining, so far as possible, a clear understanding of all phenomena that take place in the commercial transformer, that the work producing the results here set forth was undertaken. It has not been possible at this time to prepare a paper as complete as has been desired, and we trust that in the near future we may add more data to that which is here presented.

In the outstart of this paper it should be said that the results of the experiments that are here presented were wrought out jointly by Mr. Ernest Merritt, of the department of physics, Cornell University, and the writer. What we had in mind in the work was an accurate determination of the exact performance of the commercial transformer whereby one should be able to derive results and data that should enable all phases of the performances of transformers to be understood clearly, and that should show the requisite principle of proper design. It may be well to state briefly the general method we employed. A single 10-light transformer that had been made and supplied for commercial purposes for incandescent lighting with 1,000 volts in the primary and 50 volts in the secondary was selected as a sample for investigation. It probably represented fairly well the average commercial performance of transformers, and might therefore be said to embody, to a certain extent at least, proportions that have proven by experience and experiment to be best for the particular purpose for which it is supplied.

This transformer was operated under the same impressed E. M. F. supplied from the electric lighting plant in which it had been used for supplying incandescent lamps commercially. It was operated with its secondary open and the same closed through one lamp, five lamps, and 10 lamps, and under these several conditions the exact instantaneous values of the ever varying primary impressed E. M. F., primary current, and the E. M. F. at the terminals of the secondary were observed. Again under these several conditions the square roots of the mean squares of the above values and of the secondary current were also observed. Then with these observations, the dimensions and the details of the construction of the transformer, many of the facts and performances that the engineer is concerned with, is brought to light.

Naturally the first thing to be considered is the electrical measurements and how they were made. A point on the armature of an alternator always passes a fixed point in its circumference at a time corresponding to a definite value of the varying E. M. F. and current, alike, with regard to these quantities in the primary feeders, transformer, primary or secondary, etc., so long as the conditions remain constant. In our experiments, we were only concerned with the values of the E. M. F. impressed at the terminals of the primary, the primary current and the secondary E. M. F., then by changing the position of the fixed point relative to the machine, the rotating point of reference in the armature would pass the new position of the fixed point at corresponding different values for the primary E. M. F., primary current, and secondary E. M. F., with respect to themselves and the position of the armature.

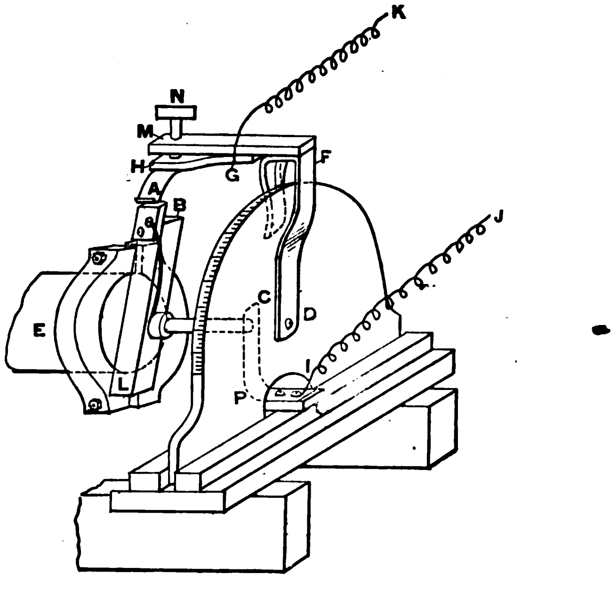


FIG. 1.

In figure 1, B, L, is a prism of hard rubber, bearing a projecting strip of brass, B, that on its upper side is filed to a dull edge. This edge is taken as a fixed point on the armature. An arm, F D, is arranged to rotate about D as a centre, a point that is in line with the axis of rotation of the armature. A semi-circular board of hard wood, attached rigidly to the dynamo frame, serves both as a support for this arm and a circumferential scale whereby the position of the arm may be observed relatively to the machine. The arm was made of brass and given the form shown in the figure. It was bent into a U shape at the top so as to pinch the board and thus remain fixed in any position desired. At the top of this arm is mounted a bar of hard rubber projecting toward the dynamo parallel to the armature axis. On its under side, fastened at G, is a brass strip, a tongue, H A, of spring brass is attached at the end and at right angles to the brass strip H G, as shown. The position of this part of the apparatus is carefully adjusted so that the point about which the arm rotates is in line with the axis of rotation of the armature and the sharply upward curved end of the tongue H A, just over the edge of the brass strip at B. Then when the armature is rotated the strip H G may be sprung inward radially by turning the thumb-screw N, until the tip of the tongue A is heard to just lightly touch the edge at B as it passes. The arm may then be adjusted by hand such that the tongue will touch the fixed edge on the armature at any desired phase of the primary E. M. F., primary current or secondary E. M. F. and current. Coaxial with the armature a small brass rod is mounted on the bar of hard rubber B L. It is connected metallically to B by means of a wire. At O, on the frame work supporting the semi-circular board, etc., is mounted another piece of hard rubber insulating and supporting the thin metallic strip, P C, that bears against the above brass rod. G and I then are the terminals of this commutating apparatus.

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[1] A paper read before the American Institute of Electrical Engineers, New York, December 17, 1889.

In figure 2, E F is a non-inductive resistance in series with the primary of the transformer which is at work. At A is the apparatus described in figure 1, and E is an electrometer reading through a wide range.

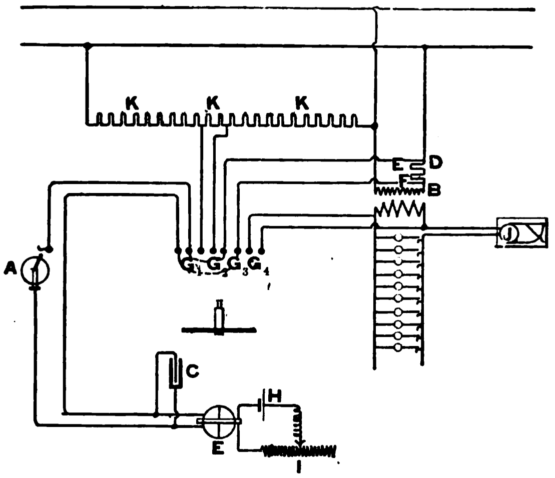

FIG. 2.

The terminals of the above non-inductive resistance and those of the electrometer are connected together through the commutating apparatus at A. Then it must be evident to all that the electrometer will become charged with a difference of potential equal to that existing between the terminals of the non-inductive resistance at the instant that the fixed edge on the armature passes the tip of the tongue in the apparatus at A. By reading the indications of the electrometer, therefore, and knowing the value of the non-inductive resistance E F, the value of the primary current corresponding to the particular phase due to the position of the arm in the apparatus at A becomes known. In a similar manner the primary and secondary E. M. F. are observed by changing the connections accordingly at G^1, G^2, G^3, G^4. Then the arm is rotated to another position, corresponding to a different phase, and the corresponding values of E. M. F.'s and current again observed as before. In this manner we proceed at equal intervals, sufficiently near, so that a curve may be determined by the values thus observed at the several intervals, such that the values of the E. M. F.'s or currents shall be accurately known at all times throughout a complete period.

A few words with regard to the electrometer at E, are not out of place here. It is the form that the writer devised especially for this and similar purposes. The essential features for an electrometer for these purposes are that it shall have the widest possible range through which it will read with accuracy. Its indications must be unvaried by the absolute potential to which it is subjected as a whole. Its law must be perfectly definite, and it is also desirable that its constant be unchanging.

Figure 3 illustrates this instrument in diagram. It consists essentially of cylindrical electrometer needle and quadrants E D. To the upper side of the electrometer needle is attached a magnetized steel mirror that acts as a magnet and as a mirror for observing the position of the same. The needle is hung by a single silk fibre, H, from a hook in the top of the case, as shown. Metallic contact from the needle to the case is made by means of a platinum wire, .0002 inches in diameter. This wire is readily provided in the desired form by using the platinum cored silver wire that is supplied by makers of surveying apparatus. It is cut the desired length, and hooks bent into shape at its terminals. By immersing all of it but the hooked terminals in nitric acid, the silver is dissolved away leaving the fine platinum core terminated by the two silver hooks. One end of this platinum wire thus prepared is linked into a hook into the top of the electrometer case and the other end into a small ring formed by a twist of the aluminum wire that surrounds the mirror C. The electrometer case is circular and the above needle and quadrants are arranged so that the magnetized mirror is at the centre of the case, and the needle and quadrants below it. About the case, as the figure indicates, is wound a coil, B B, of rather fine insulated copper wire. The magnetized mirror and this coil then, when the latter is in the magnetic meridian, constitute an arrangement similar to that of a tangent galvanometer. In the electrometer, the needle, case, and one set of quadrants are connected together and form one terminal and the other set of quadrants, being connected together, form the other terminal of the instrument, in the manner set forth in the diagram. Thus then, when the electrometer terminals are subjected to a difference of potential, the needle is acted upon by a couple brought about by the electrostatic forces and is deflected from its position of equilibrium. Then, as is shown in figure 2, current from a gravity cell in circuit with a suitable rheostat is sent through the coil on the electrometer in such a direction that the needle is brought toward its zero position by the action of the coil, carrying the current, on the magnetized mirror. The current is then further adjusted till the needle stands balanced at zero under the mutual action of the electrostatic and the electro-magnetic forces. Under such circumstances then the difference of potential is proportional to the square root of the current.

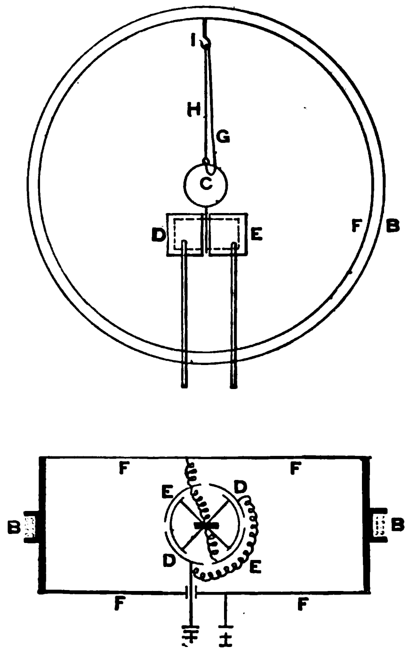

FIG.3.

If we can, as was the case when the measurements here presented were made, consider the E. M. F. of our cell constant, the difference of potential is likewise proportional to the square root of the reciprocal of the total resistance in circuit with the cell. Parallel readings, taken with a standard voltmeter throughout a range varying from 3 to 600 volts, gave identical results showing no deviation from the above law and an unvarying constant. On account of the metallic case and its connection to the rest of the apparatus, the indications of the electrometer are, so far as could be observed, entirely independent of the absolute potential to which it is subjected as a whole. In figure 2, when contact was made at A, and the electrometer charged to the potential difference to which its terminals were then subjected it was found that considerable of the charge was dissipated by leakage during the course of a revolution of the armature, no matter how good the insulation of the apparatus was. A one-half microfarad mica condenser was then placed in multiple arc with the terminals of the electrometer at C. Then after a few revolutions of the armature the condenser became charged to precisely the same difference of potential existing at the terminals of the electrometer D B, as shown in figure 2, when the rotating edge on the armature passed the tip of the tongue on the arm at A.

Under these circumstances the leakage that occurred was entirely unobservable as compared to the charge in the condenser during the course of time required for the armature to make many revolutions. Thus arranged then the electrometer would give accurate readings of the primary and secondary E. M. F.'s and primary current corresponding to the connection of its terminals and the position of the arm at A. Again, the square root of the mean square of any of these values could at any time be read from the electrometer by short-circuiting the apparatus at A, and cutting out the condenser at C. For the purpose of obtaining the curve of impressed E. M. F. and the $\sqrt{\text{mean}^2}$ of the same, twenty-two 50 volt lamps were put in series across the primary circuit. The $\sqrt{\text{mean}^2}$, of the impressed E. M. F. in the primary was then obtained by reading, by means of the electrometer with the condenser cut out and the commutating apparatus short circuited, the $\sqrt{\text{mean}^2}$ difference of potential existing between each set of two lamps. In this way 11 readings were obtained, the sum of which was the total impressed E. M. F. This served as a calibration of the non-inductive resistance formed by the lamps. At the same time that these observations were made, two lamps were determined upon to be used in all subsequent observations on the total E. M. F. The above observations served then as a calibration for the indications of the two lamps thus to be used. For the constant obtained by the ratio of the above total E. M. F. to the E. M. F. of these lamps taken at the same time always served to deduct the total $\sqrt{\text{mean}^2}$ or any particular value corresponding to a particular phase of the impressed primary E. M. F. when the same had been observed with regard to the two lamps in the group thus set apart. In this way we avoided the direct measurements of the total impressed E. M. F.

Two 50 volt lamps, E and F, were placed in series with the primary for a non-inductive resistance, and, as previously stated, the $\sqrt{\text{mean}^2}$, and the values corresponding to any particular phase of the fall of potential through these lamps were observed. This gave a measure of the $\sqrt{\text{mean}^2}$ or any particular value corresponding to a particular phase of the primary current, when the resistance of these lamps was known at the temperatures to which they were brought by the current. A curve of resistance corresponding to the range of currents through which we used these lamps was determined carefully by Mr. Merritt, at the Cornell magnetic observatory.

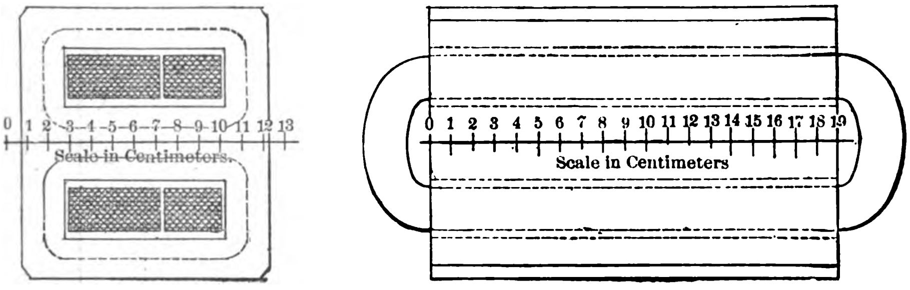

FIG. 4.

In series with the secondary circuit was placed a gravity ammeter containing a few small turns, and correct in its adjustment. It indicated the $\sqrt{\text{mean}^2}$ in the same way that an electro-dynamometer would have done. The observing of the various values of the secondary E. M. F. required no special arrangement,—this was done direct in all cases. Since the secondary was always at work on a circuit possessing almost no inductance, no determinations of the curve of secondary current were made, for it would be found to be so nearly in unison with the secondary E. M. F. and possess all the characteristic variations of the same. The $\sqrt{\text{mean}^2}$ of its value was always known from the indications of the ammeter. As a load for the transformer ten 16 c. p. 50 volt lamps were provided that could be turned on and off as desired, and they were at an average distance from the transformer of not more than five feet.

G^1, G^2, G^3, G^4, represent, in figure 2, the various terminals conveniently arranged on a switch-board for ready adjustment for any desired set of connections. The adjustable resistance at I, consisted of a plug resistance box, enabling one to get any number of ohms in circuit from 100,000 down. It was very conveniently arranged ; but a suitable slide rheostat and a damped magnet on the electrometer needle would have greatly facilitated the rapidity with which observations could be taken. The mode of procedure was to set the brush at some suitable point of starting out, then corresponding to this point readings of the instantaneous values of primary E. M. F. were made. When lamps were turned on in the secondary, the ammeter in that circuit was also read. The brush was then moved forward to a new position and the above readings repeated. This was continued until we had gone over a complete period of two alternations, then the $\sqrt{\text{mean}^2}$ readings of the primary and secondary E. M. F.'s and primary current were made. To do this required a period of time covering usually not more than two and one-half hours. Careful observations were made which showed that the insertion of one, two, or three lamps in the primary circuit *did not perceptibly change the relation* of the primary E. M. F. and current and secondary E. M. F. The indications of the ammeter gave data for correcting for variations of the speed of the dynamo, that throughout was not great.

The following data should be given with regard to the transformer that was used by us :—

Number of turns in the primary coil..........	675.
" " " secondary coil........	35.
Resistance of the primary..................	21.8 ohms.
Resistance of the secondary..................	.04 "

Figure 4 is furnished with a scale to which it was drawn, so that from it any details as to dimensions of the transformer can be obtained.

The iron discs of the magnetic circuit of the transformer were made one-half millimeter in thickness, and its surface merely oxidized, so that no special insulating material was provided between the laminations. The total volume of laminated iron used in the transformer was 2,050 cubic cms.

The mean cross-section of the magnetic circuit was 63.3 square cms., and the mean length of the magnetic circuit 30.8 cms.

The following observations with the secondary on open circuit and working on one lamp, five lamps, and 10 lamps were made and have been plotted in figures 5, 6, 7 and 8. The corresponding curves located by them, drawn in by the scales designated.

Secondary on open circuit.

(See figure 5.)

Brush reading.		Primary E. M. F.	Current.	Secondary E. M. F.
21		119	.20	5.5
20		855	.05	62.7
19		1250	.07	63.4
18		1420	.11	70.7
17		1330	.14	66.8
16		900	.19	46.0
15		45	.21	00.0
14		751	.04	37.8
13		1210	.08	62.0
12		1390	.12	72.0
11		1410	.15	72.5
10		1100	.18	57.8
9		355	.21	14.5
8		645	.08	32.3
7		1130	.04	57.8
Observed	$\sqrt{\text{mean}^2}$	1025	.14	54.5
Calculated from curves	$\sqrt{\text{mean}^2}$	1030	.147	53.5

Secondary closed through one lamp.

Secondary on Open Circuit.

(See figure 6.)

Brush reading.		Primary E. M. F.	Current.	Secondary E. M. F.
28		605	.225	31.4
27		330	.125	15.3
26		917	.048	45.2
25		1300	.179	67.6
24		1403	.215	71.7
23		1300	.235	67.1
22		820	.239	43.8
21		132	.185	4.7
20		835	.000	3.9
19		1238	.151	61.5
18		1420	.215	71.7
17		1363	.238	68.4
16		1026	.246	52.7
15		170	.215	9.7
14		793	.048	35.6
Observed	$\sqrt{\text{mean}^2}$	1053	.196	52.3
Calculated from curves	$\sqrt{\text{mean}^2}$	1021	.190	51.4

Mean of ammeter readings..... ... 1.26

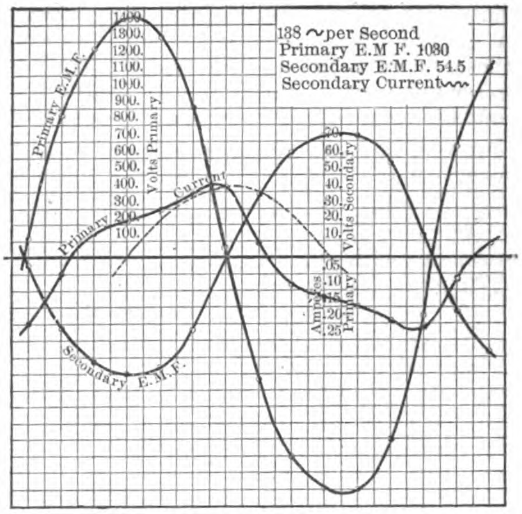

FIG. 5.

Secondary closed through five lamps.

(See figure 7.)

Brush reading.		Primary E. M. F.	Current.	Secondary E. M. F.
29		956	.449	40.3
28		41	.250	10.4
27		723	.000	28.9
26		1194	.356	54.8
25		1447	.495	69.1
24		1350	.483	67.2
23		1103	.453	57.6
22		293	.304	21.5
21		560	.000	19.8
20		1110	.318	48.8
19		1383	.464	65.7
18		1429	.511	70.0
17		1228	.500	60.3
16		567	.374	24.0
14.7		585	0.030	23.4
Observed	$\sqrt{\text{mean}^2}$	1050	.390	51.0
Calculated from curves	$\sqrt{\text{mean}^2}$	1036	.383	50.6

Mean ammeter reading........ 5.83

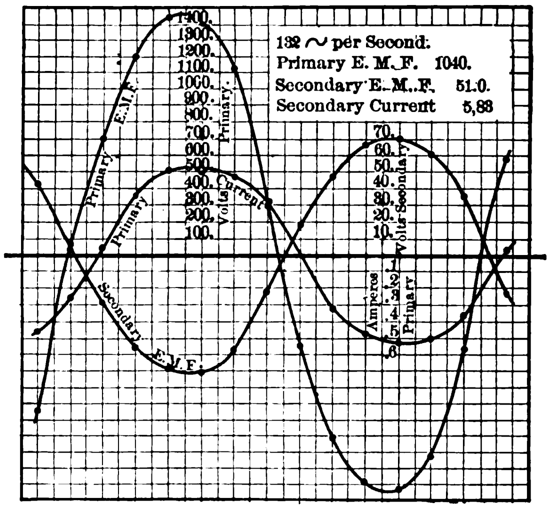

FIG. 6.

Secondary closed through ten lamps.

(See figure 8.)

Brush reading.		Primary E. M. F.	Current.	Secondary E. M. F.
21		138	.242	5.2
20		826	.276	29.7
19		1237	.642	53.5
18		1378	.795	64.0
17		1300	.821	64.3
16		924	.700	51.1
15		63	.340	15.0
14		698	.188	23.7
13		1138	.587	49.0
12		1370	.810	63.7
11		1343	.844	66.0
10		1073	.771	26.5
9		323	.479	26.5
8		590	.000	17.0
7		1117	.538	42.8
Observed	$\sqrt{\text{mean}^2}$	1040	.631	49.3
Calculated from curves	$\sqrt{\text{mean}^2}$	1020	.634	49.3

Mean ammeter reading.......... 10.65

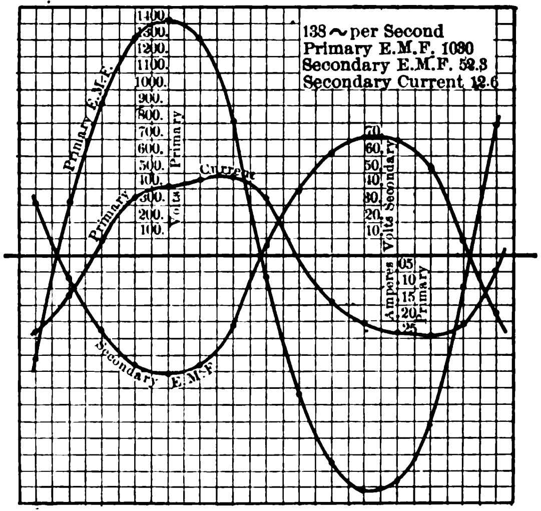

FIG. 7.

In figure 9 are plotted curves deduced from the foregoing observations, that show clearly the rate at which energy is given to the transformer, or that the transformer restores to the circuit at all points of a complete alternation for the several conditions under which the transformer was operated. The curves themselves show so clearly this particular part of the performance of the transformer that nothing more need be said about them, except to give the percentages of the work given to the transformer that is restored to the circuit by it under the several foregoing conditions :—

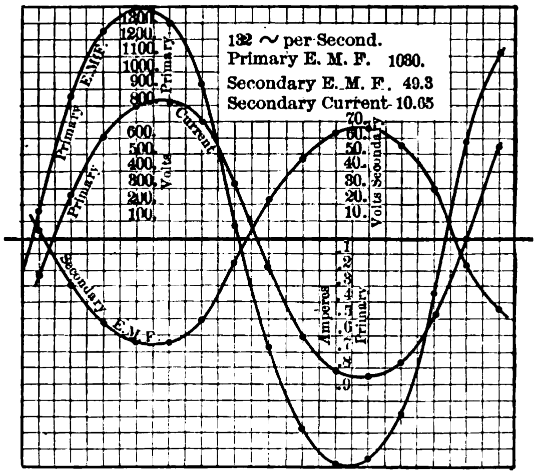

FIG. 8.

Open circuit	6.8%
One lamp	3.9%
Five lamps	.96%
10 lamps	.36%

The above observations and data are ample wherewith to compute the various losses of energy that take place in the transformer under the several loads and under no load, and the deduction of the corresponding efficiencies. These values have been computed and are given in the following table.

Proper corrections have been applied for the two lamps in series with the primary of the transformer.

Secondary E.M.F.*		Primary watts.	Secondary watts.	Efficiency.	Total loss in watts.	Hyster. loss in watts.	Heating loss. Primary watts.	Heating loss. Secondary watts.
Primary	10.20							
Second'ry, open	52.3	96.1	0.0	0.0	96.1	95.7	0.4	0.0
One lamp	52.3	159.1	64.3	41.1%	94.8	93.9	0.9	0.0
Five lamps	50.1	388.6	300.9	77.5%	87.7	83.1	3.3	1.3
10 lamps	47.5	607.9	525.0	86.6%	82.9	69.7	8.7	4.5

In figure 10 these values have been plotted to scales there indicated, and the respective curves that they determine have been drawn so that one can plainly see the exact performance of the transformer under all loads.

It is interesting to note that this transformer might be loaded to twice its rated capacity and the heating of the coils would still be less than that of the iron, although the heat produced by the iron grows less as the load comes on. Likewise, that its efficiency would not yet have reached its maximum and that it would have a value of 92 per cent. In figure 10 the outer curve represents the relation between the magnetizing current in the primary and the degree of magnetization for all points of a complete cycle. The values locating the curve expressing this relation were readily deduced from the observations made when the transformer was working on open circuit. In figure 5 the dotted curve represents the curve of primary current that would be found, should Foucault currents be known to be absent, and the relation of ampere turns and magnetization be the same going up as coming down. Then if Foucault currents were present the dotted curve would have a component at a quarter of a period in advance. This would produce a negative lag in the dotted curve. From the position of the actual primary current, it is plainly seen that but a very small component of the above nature is possible, and that the energy that is wasted by eddy currents must therefore be small. The radical departure of the primary exciting current from the approximate sinuous variation of the primary impressed E. M. F. is plainly brought out to be due to *hysteresis*. From the preceding consideration it is also evident that almost the entire advance of the exciting current and, therefore, the corresponding dissipation of energy, is due to the same cause.

It was thought of much interest to see what amount of hysteresis should be indicated by carrying the transformer slowly through the same cycle of magnetization that it went at the rate of 138 cycles per second when at work on the circuit with its secondary open. Accordingly, by Ewing's method modified for the purpose by Dr. Sumpner, Mr. Merritt determined the inner curve shown in figure 10. We regret greatly not to have had time for a careful redetermination of this inner curve, and carry the magnetization to the same maxima that was done in the transformer when on the circuit. The agreement between the cards would have been more marked even than in figure 10.

The assumption made by Mr. Swinburne in his remarkable and valuable paper on the "Design of Transformers" (proceedings of the British Association, 1889), would, therefore, be fully substantiated. Mr. Mordey's experiments, in which *hysteresis* and *Foucault current* losses producing a common loss were determined, were performed by cycles of magnetization produced by rotation in which the degree of magnetization did not vary in amount but direction, and cannot be said to throw light on the correctness of Mr. Swinburne's assumption. Some, commenting on this paper, have used Mr. Mordey's results as evidence that these assumptions are wrong.

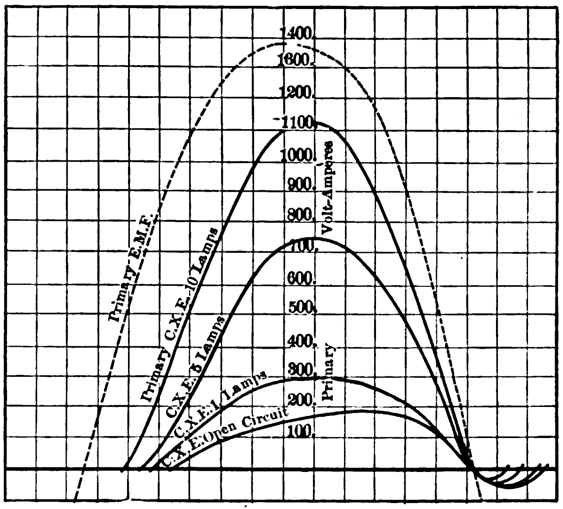

FIG. 9.

By a knowledge then of the magnetic properties of the iron, with which a given transformer is to be built, and the methods made use of by Mr. Swinburne, its efficiency is something that can be correctly predetermined.

The importance of making a transformer produce the same E. M. F. at the terminals of the secondary under all loads, asserts itself when it is used for incandescent lighting. In the transformer, under consideration from the ratios of the primary and secondary turns, the E. M. F.'s that they produced, and the variations of magnetization that had to take place through the primary, in order that the same should produce an E. M. F. equal and opposite to that of the primary impressed E. M. F., the magnetization produced through the secondary and the magnetization set up about the primary in its own air space are determined. In the present transformer this "leakage" of magnetism amounted to about 1.2 per cent. When the transformer works on full load 4.5 times as much current passes through the primary, and the "leakage" of the primary in its own space is 4.5 times as much as on open circuit and becomes 5.4 per cent. This value, together with the small drop due to the actual resistances of the transformer coils, accounts for the fall of 3.5 volts that was observed by turning on all of the ten lamps.

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*The values given in this column have not been corrected for the two lamps in series with the primary for the first three conditions and the one lamp that was used for the last. With 10 lamps, where one lamp was used in the primary this correction amounts to an increase of the secondary E. M. F. of three per cent. On open circuit and one lamp it is negligible and three per cent. increase for five lamps. When this correction is applied the drop of 3.5 volts obtained is what was observed by direct measurement on the secondary.

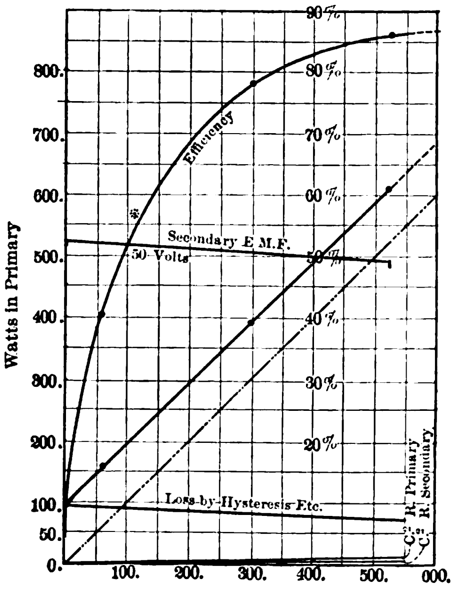

FIG. 10.

Attention might be called to a similar "leakage" in magnetism that takes place in the secondary circuit. It is plainly brought out in figure 8 by the lag of the secondary E.M.F. This magnetic "leakage" producing a self-induction is proportional to the secondary current. The rate of change of this quantity then is proportional to the E. M. F. that it produces. This E. M. F. is, therefore, a quarter of a period behind the secondary current, and results in producing a small lag in primary and secondary currents and secondary E. M. F.

Finally, there is a curious behavior of this transformer that remains to be accounted for. This is the considerable decrease in the loss of hysteresis as the transformer is loaded down, that is not to be accounted for by rise of temperature or the falling off of the magnetization due to the increased "leakage" about the primary in its own air space.

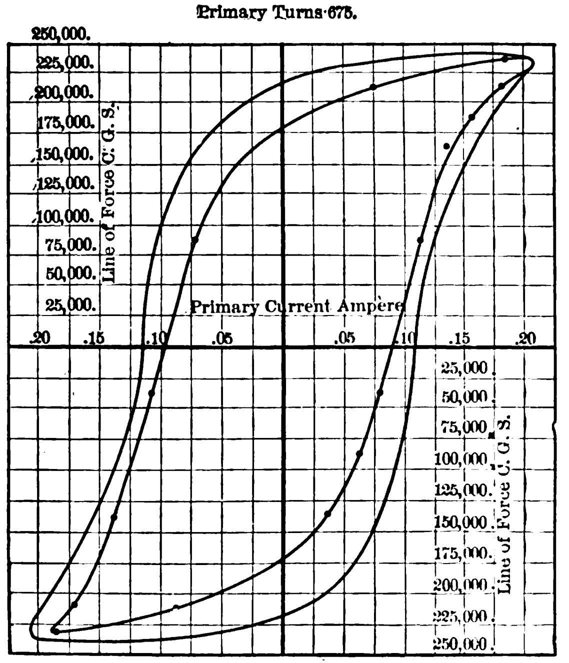

FIG. 11.

The following reason suggested itself to the writer, why this should take place :—

Mechanical shock has been shown to greatly reduce loss by hysteresis when iron is passed through cycles of magnetization. Since the currents are at all times opposite each other in the two coils of a transformer, strong repulsion occurs when these currents are at a maximum and no force is exerted when they pass through zero. So it follows that they continually keep thrusting each other apart when at work and add to the disturbance of the laminated iron that already exists on account of its changing magnetization. This increasing of the mechanical vibration of the iron, may therefore account for the above-mentioned phenomenon.

On open circuit the maximum magnetization of the iron per square cm. was 3,850 C. G. S.

Loss by hysteresis per cycle per cubic cm., neglecting Foucault currents, .046 watts at 138 ∿ per second.

Coercive force per centimeter of the iron, 2.76 C. G. S.

In conclusion, the writer would say that the data here given show for themselves so clearly the advisability of providing some practical means for breaking the primary circuit of the transformer when not in use, that the strong advice of Mr. Swinburne in concluding his paper need not be repeated.

A NEW VIEW OF TELEPHONE INDUCTION.[1]

One of the most peculiar developments connected with the introduction of the telephone was the presence of remarkable sounds, which were heard when the telephone line was of any considerable length. Sometimes it sounded as though myriads of birds flew twittering by ; again, sounds like the rustling of leaves and the croaking of frogs could plainly be heard ; at other times, the noise resembled the hissing of steam and the boiling of water. Even a display of Aurora Borealis causes powerful currents in the telephone. Some of these disturbances have been more or less satisfactorily accounted for by assuming differences of potential at the two ends of the line ; by the sudden heating or cooling of the line ; and by the passage of electrified bodies of air or clouds. Another very curious effect was observed when the first two telephone wires were run parallel to each other on the same cross-arm for the distance of even a few miles ; it was found that, although the insulation of the lines was high, a conversation carried on over one wire could plainly be heard on its neighbor. This overhearing is commonly called "cross-talk." As the number of telephone wires increased, and their bunching together in cables became necessary, it was found that, in addition to the cross-talk, there was another element of trouble added, which was due to the electrostatic effect of the cable, and caused the voice to be transmitted in an indistinct and muffled manner. This evil exists to such an extent that where cables are used the speaking limit is soon reached. While a study of the strange noises heard in the telephone might be of interest, I shall in this paper limit myself to the consideration of cross-talk and to the action which takes place when wires are bunched in cables. In the simple case of inductive cross-talk first cited, in which two telephone wires are strung parallel on the same cross-arm, the presence of cross-talk is said to be due to dynamic or current induction—that is, if a current commences to flow in one of the wires from north to south, it will at that instant cause an induced current to flow in the other wire in the opposite direction, from south to north. As the telephone current is constantly changing its direction and strength, this explanation seems to apply and is the one given in the text-books. This is the kind of induction referred to in the law of Lenz, and applies to induction coils and to parallel wires when the current is of sufficient strength. I shall speak of this hereafter as electro-magnetic induction. I shall now describe some experiments which seem to prove that the induction between telephone wires is due to electrostatic rather than to electro-magnetic action. I will first show a case of electrostatic induction between telephone wires in which there is a neutral point at the centre of the secondary wire, at which point there is no induction, while at the ends marked inductive effects are noticeable.

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[1] Paper read November 21st, 1889, by Mr. John J. Carty, electrician of the Metropolitan Telephone and Telegraph Co., New York, before the New York Electric Club.

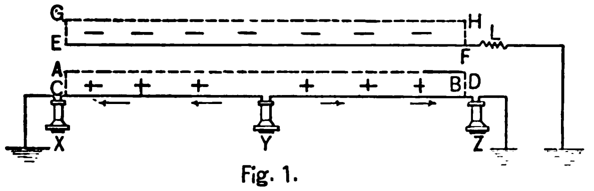

Fig. 1.

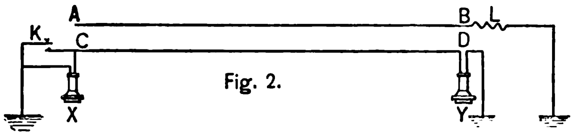

Fig. 2.

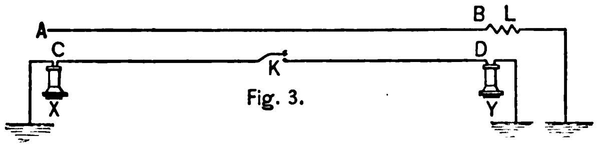

Fig. 3.

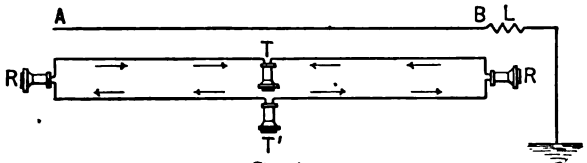

Fig. 4.

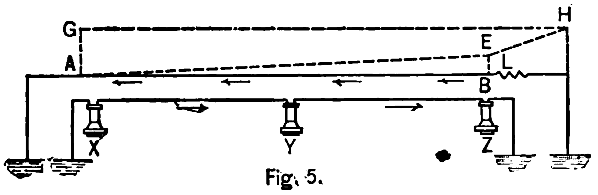

Fig. 5.

In figure 1, E F and C D are two well-insulated parallel telephone wires, each 200 feet long, and placed one-eighth of an inch apart. E F is open at one end and connected to ground at the other through a Blake transmitter, L, in the ordinary manner. In front of the Blake transmitter I place a vibrating tuning fork, which acts on the transmitter in the same manner as the voice, and which produces impulses on the line E F of the same strength as voice currents. At the centre of the line C D we have the telephone Y, and at the extreme ends the telephones X and Z. With the tuning fork at L in operation, tones are heard at X and Z, but the middle telephone Y is silent. A study of the changes of potential produced in the wire E F by the transmitter will give us an explanation of this phenomenon. As is well known, the telephone current is an alternating one, and the potential of the line E F varies constantly, and is changed from positive to negative many times per second. The wire E F being open at E would be at the same potential throughout. It is assumed that at a given instant the height of potential at F would be represented by the dotted line F H; then the potential at E would be represented by the dotted line E G, and the total charge on E F would be represented by the rectangle E G H F. We will assume that this charge is of the minus sign. The existence of this charge on E F presupposes the presence of a charge of opposite sign on C D, which would be represented by the rectangle A C D B. Now, suppose the potential on E F becomes zero, owing to the operation of the transmitter, then the whole charge on E F gets to earth at the grounded end of E F; but the charge on C D has two paths to earth, one at C and the other at D. This results in two currents, as shown by the arrows, one flowing to earth through the telephone X and producing sound at X, and the other flowing to earth through the telephone Z and producing sound at Z. No current flows through the telephone Y, and consequently no sound is produced therein. Again changing the potential at E F causes a corresponding set of currents, but in opposite directions to those first described, meeting in the centre and producing no sound in the centre telephone, but causing the end telephones to give out sounds the same as in the first instance. Inasmuch as the line E F is opened at one end, and therefore has almost an infinite resistance, it is clear that this phenomenon is purely an electrostatic one. In this and the succeeding experiments I have not attempted to give the exact shape of the induced charge, as it would unnecessarily complicate the subject and would not in any way affect the result. As a matter of fact, the dotted line A B should slope off from the centre toward the ends. With the line E F grounded through an ordinary subscriber's line and instrument, the effect is the same as when the line is open, and the neutral point is still found. This is because the telephone current, even when flowing in a close circuit, is so weak that it is not capable of producing a magnetic field of sufficient strength to affect the neighboring wire, or the magnetic effect is so small that it is obliterated by the movement of the static charge. For convenience in some of the succeeding experiments, the disturbing wire will be shown open at one end. If there is no current flowing at the neutral point, opening the wire at that point should have no effect on the telephones located at the ends. In figure 3 A B is the disturbing wire with the transmitter L arranged as before; K is a key located at the neutral point of C D. With the transmitter L in operation, no change is produced in the tones heard at the telephones X and Y by opening and closing the key K. If this induction were electro-magnetic, opening the line C D would prevent current from flowing in any part of the circuit. In figure 2 we have another proof of the electrostatic nature of telephone induction. A B is the usual disturbing wire with its transmitter L. C D is the secondary wire with the telephones X and Y located at the ends, as in the previous experiment. By means of the key K the telephone X may be cut in and out of the circuit. With the key open the usual tones are heard at X and Y. Now, if the induced current flowing in the circuit C D is due to electro-magnetic induction, upon short circuiting the telephone X and thereby reducing the resistance of the circuit C D the strength of the induced current should be increased and the tone at the telephone Y should be correspondingly louder. But this is not the case, as on closing the key the sound at Y instead of being increased, entirely disappears. This is because the charge on the wire C D finds an easy path to earth through the key, and such a small portion of the charge goes to earth through the telephone Y that no audible effect is produced therein.

Figure 4 shows the disturbing wire A B arranged as before, but the secondary wire, instead of being put to earth at both ends, has its circuit completed by a second wire placed outside of the field of A B. With this arrangement neutral points are found at T and T^1, while the usual disturbances are heard at telephones R and R^1, located at the ends. In this case, a movement of the static charge takes place in the metallic circuit, causing at one moment a set of currents starting from T^1 in both directions through the end telephones and meeting at T, and at the next instant the reverse takes place. I will now show some of the effects of electro-magnetic induction, at the same time suppressing electro-static induction.

In figure 5, A B is the disturbing wire as before, but grounded through a short thick wire at A. Instead of placing the tuning fork in front of the transmitter L, and acting on it through the air, producing delicate currents like voice currents, an automatic circuit breaker and five cells of Leclanché battery were connected in the primary circuit of the transmitter, thus producing in the line A B alternating currents of great strength. The secondary wire containing the telephones X, Y and Z, is of the same length, and at the same distance from the disturbing wire, as in the previous experiments. With the circuit breaker at L in operation loud musical tones are heard at X, Y and Z, and the tone is the same in all three telephones, the neutral point in this case having disappeared. This is a true case of electro-magnetic induction, because short circuiting the telephone Y increases the sound in the remaining telephones, and leaving the short circuit on Y and short circuiting the telephone X still further increases the sound at Z. This latter experiment furnishes a most striking contrast to the result obtained in figure 2, where, by short circuiting the telephone X, the sound was completely removed from the telephone at the other end of the line. Another proof that this is electro-magnetic induction, is found in the fact that if the line be opened at Y the sound disappears from all the telephones. If the line A B were opened at A, the potential along the line would be constant, and the charge which A B would take would be represented by the rectangle A G H D, but when the line is grounded at A through a low resistance, there is, of course, a fall of potential along A B; the principal drop, however, occurring in the secondary coil of the transmitter L, the line B E representing the height of potential at the terminal of the coil, and the electro-static effect which the line A B would have is represented by the triangle A E B. This triangle, although exaggerated in the diagram, is still much smaller than the rectangle A G H D, and explains the absence of electrostatic induction between the wires, while the powerful current generated in L, and the comparatively low resistance through which it has to flow, accounts fully for the electro-magnetic effects observed. I have made a large number of laboratory experiments and observations on actual telephone lines, all of which point strongly to the conclusion that electro-magnetic induction does not exist in telephone lines outside of the telephone and transmitter. This view of the subject, applied to the theory of transpositions of metallic circuits and to the action of wires in cables, gives the only satisfactory explanation of observed phenomena.

Now, we come to the important question: Can this electrostatic induction be prevented? In answer to this, it can be said that the cross-talk due to electrostatic induction can be eliminated by properly constructed metallic circuits. But there still remains the muffling effect referred to in the first part of this paper. This is sometimes called "electrostatic retardation," and comes in wherever two telephone conductors are run close to each other for any great distance. Where telephone wires are strung upon poles and are at a distance of a foot or more from each other, this action is very small, but where they are bunched together in cables, a hundred or more within a two-inch pipe, it is very great. It is a curious fact, however, that the amount of this trouble, other things being equal, depends on the character of the insulating medium or dielectric, as it is called, but is independent of its specific insulation resistance, the induction being less when air is used as an insulator than with any other substance among the materials adopted in practice. Dry cotton, paper, and silk rank next to air in this respect, but when gutta-percha or any of the rubber compounds are used the induction is much greater than with the other materials mentioned. This peculiar property of an insulator—*i. e.*, the facility with which it allows induction to take place through it—is called its "specific inductive capacity." In the present state of things, then, the only way to overcome electrostatic retardation, after having an insulator or dielectric of the lowest specific inductive capacity, is to increase the distance between telephone conductors. It is evident that in underground systems this distance can never be great. In all of our large city underground systems the space which is allowed for each wire is 0.125 of an inch.

This putting of wires underground in cities is the only bar to a universal system of telephony; and if direct air lines were built, New York and Chicago would be placed within speaking distance of each other at once. To place telephone wires underground, and maintain the same efficiency as in overhead lines, would require an insulation on each wire of over 2 feet in thickness, and instead of getting 50 pairs of wires into a 3-inch pipe, as at present, a tunnel occupying half the street would be required for one cable alone. When we consider that a telephone office of even moderate size would require about a hundred such gigantic cables, it is seen how almost hopeless the case becomes. Most engineers think that this difficulty is inherent in the problem, and that the electrostatic action can only be overcome by separating the wires as already stated. In view of the recent researches tending to give us a deeper knowledge of the nature of electricity which have been conducted by Hertz and others, I think there is reason to hope that some other way out of the difficulty may be found. You are all, no doubt, familiar with those celebrated experiments wherein electrical undulations of many million times per second were produced, and, although they were transmitted along a conductor with the velocity of light, yet they followed each other with such rapidity that nodal points were produced, the location of which determined the length of the waves. These waves have been produced in various ways, and by means of large prisms of pitch and by metallic mirrors they have been refracted, focused, and reflected; in fact, they have been found to obey much the same laws as light waves. I think it must follow from these experiments that our disturbing wire A B is throwing off, laterally, waves of great length, and that these waves impinging upon the adjacent wire C D, produce the various inductive effects observed. Now, if by some means these waves could be deflected from their course and prevented from falling on the wire C D, it follows that there would be no disturbance whatever produced therein. We know that if these waves were of the same length as light waves, this action could be prevented by the interposition of a properly shaped lens of glass, or by a mirror; or if they were of the length used in Hertz's experiments a lens of pitch or a metallic mirror would have the same result. Now, although the telephone waves are of great length, it seems possible that by interposing a properly shaped dielectric or combination of dielectrics, that an interference or refraction might be produced which would have the desired result.

This electrostatic problem is one of the most important, and until within a year or two the least studied, and is at present the least understood of all the various difficulties with which we are confronted, and the reward which awaits its proper solution is greater than that which fell to the lot of the inventor of the telephone itself.

.... THE same thing may appear intrinsically absurd, or intrinsically reasonable, according to the year of grace in which we hear of it.—*S. P. Langley.*

.... THERE is a clique of mathematical cooks who have axes of their own to grind; a clique who writes the electrical books, and who are very active in scientific societies, who are not satisfied simply to perform the functions nature has qualified them for doing, but they do their best to ignore those to whom they are indebted for the hares they cook and dress and eat.—*S. Alfred Varley.*

.... HOW inexplicably sometimes error flourishes, grows and maintains an apparently healthy appearance of truth, without having any root whatever.—*S. P. Langley.*

THE DANGERS OF ELECTRIC LIGHTING.[1]

A REPLY TO MR. EDISON. BY GEORGE WESTINGHOUSE, JR., PRESIDENT OF THE WESTINGHOUSE ELECTRIC CO.

No one will now question the great benefit of the electric light to the public. By the rays of the brilliant arc lamp our streets are better lighted than ever before, with a corresponding increase in security both to life and property, while the incandescent lamp supplies our homes with the most agreeable artificial illumination known to science, and one which, at the same time, is absolutely free from the deleterious products of combustion incident to the use of gas or oil.

The use of electricity for supplying light and power has now become as much a part of our every-day life as the railway, the steamship, the street car, or the gas supply. In fact, we live in a time when power is made in every way subservient to the comfort of the people. It is employed in nearly every useful industry, with a full knowledge that such employment has been and always must be attended with an appreciable degree of danger. Electricity is one manifestation of power. It represents a form of mechanical energy capable of being utilized for innumerable purposes. Indeed, were it a question of prohibiting the use not merely of electricity, but of all other things dangerous to life, we would no longer have fires to warm us or light to enable us to see, and, in fact, would be deprived of most of the necessaries and comforts of existence. As has been the case with the utilization of all other forms of energy, the demand for the most economical methods will ultimately prevail, provided these can be made safe, as they most certainly can, by the exercise of proper precautions.

Electric lighting, unlike many other industries protected by patents, has been followed with keen interest at every step by the public at large, but among more immediately interested parties the struggle for the control of the electric light and power business has never been exceeded in bitterness by any of the historical commercial controversies of a former day. Thousands of persons have large pecuniary interests at stake, and, as might be expected, many of them view this great subject solely from the standpoint of self-interest. That the public may to some extent understand the mass of literature now being printed with reference to the use of electric currents of both high and low tension, it is necessary that something of the story of this business rivalry should be told.

The successful use of the Jablochkoff electric light in Paris, in 1878, was the beginning of a new era in a field which had not remained wholly uncultivated during the preceding thirty years, although with unimportant commercial results. In 1877 and 1878 we find William E. Sawyer, Charles F. Brush, Hiram S. Maxim, Edward Weston, Thomas A. Edison, and others entering this alluring field of invention. In 1877 Sawyer took out three patents of more than ordinary importance, in view of what has since become the practice in electric lighting. Early in 1878 he associated with himself Albon Man, who became a joint inventor with him of several electric-lighting inventions, the promising results from which led to the formation, on July 8 of that year, of the Electro-Dynamic Light Co., of New York. The objects for which this company was formed were stated as follows:—

> The production of light and power by means of electricity; the lighting of streets, buildings, and other places; producing, conducting, and distributing electrical currents for lighting and other purposes, and the manufacture and sale of all machinery necessary for or adapted to accomplish the purposes named.

Charles F. Brush early invented and perfected a dynamo, an arc lamp, and a method of operation whereby a number of such arc lamps could be used on one circuit, principally for street lighting purposes. To make and sell Mr. Brush's inventions, there was organized the Brush Electric Light Co., of Cleveland, Ohio.

In September, 1878, appeared the first announcement of Mr. Edison's discoveries in electric lighting, and on October 17, three months after the formation of the Electro-Dynamic Co. to operate Sawyer and Man's electric light inventions, the Edison Electric Light Co., of New York, was organized. To introduce the inventions of Maxim and Weston, there was formed the United States Electric Lighting Co., of New York, and thus four large corporations were started almost simultaneously upon a career of competitive business. The energy and money since expended by each of these corporations in efforts to thwart the progress of the others has mutually embittered the interested parties to a degree that can with difficulty be comprehended by those not immediately concerned in the strife.

Mr. Edison, already a well-known inventor in telegraphy, apparently had his attention drawn to this subject by a visit to Mr. William Wallace, of Ansonia, Conn., in September, 1878. There he saw Mr. Wallace's dynamos feeding eight electric lights at one time, and also witnessed the transmission of power by electricity from the Naugatuck river, a quarter of a mile distant. The spirit in which he entered the electric light business would seem to be indicated in the following extract from the New York *Tribune* of September 28, 1878:—

> "Mr. Wallace's machines produce electricity which can be made available for electric light." Mr. Edison continued:—"I have let the other inventors get the start of me in this matter somewhat, because I have not given much attention to electric lights, but I believe I can catch up to them now." * * * "Now that I have a machine (Wallace's) to make the electricity, I can experiment as much as I please." "I think," he added, smiling, "there is where I can beat the other inventors, as I have so many facilities here for trying experiments." "If you can make the electric light supply the place of gas, you can easily make a great fortune," the reporter suggested. "I don't care so much for a fortune," Mr. Edison replied, "as I do for getting ahead of the other fellows."

Setting out with this determination, it is perhaps no wonder he has worked so energetically. Reviewing his inventions and utterances, it is evident that he believed from the beginning that the system of gas distribution was the thing to be copied, and that electric conductors could be laid under the streets with branches or connections to each house, supplied by generators located in central stations; but this system necessitated the limitation of the electric pressure to that which the lamps could be made to endure—in practice about 110 volts. The formidable quantities of copper required to conduct the necessary volume of current at this low pressure soon led to the development of what is known as the Edison "three-wire" system of distribution, an improvement founded upon earlier patents of Sawyer and Brush. This system permits a pressure of 220 volts on a circuit equipped with 110-volt lamps, and requires for the whole installation only one-quarter of the weight of copper conductors necessary with the two-wire system.

It must be constantly borne in mind that the pressure of this direct-current system is necessarily limited to 220 volts by the conditions of the lamp, and also that the underground mains in all directions are interconnected, forming what is termed a mesh-work, analogous to the gas-distribution system, but with very important differences, hereafter explained at length. The cost of copper required for mains of sufficient conductivity to avoid a decrease in light by reason of large consumption, even at moderate distances, was found to be prohibitive, and this fact necessitated a system of "feeders," through which the electricity is forced against a very considerable resistance. These feeders are connected at various points to the meshwork of mains so as to maintain at such points an approximately constant pressure. The generators at the central stations deliver their product collectively into common feeders and mains, and with a large plant an enormous energy is constantly exerted in these mains.

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[1] From the *North American Review*, December, 1889.

Any plan of distribution involving the meshing of the mains underneath the streets, with all house wires connected directly thereto, is regarded by the majority of competent electrical engineers as in many respects radically defective; so defective, in fact, that, unless the use of alternating currents can be prohibited, it seems destined to be wholly supplanted by the more scientific and in all respects (so far as concerns the users or occupants of buildings) far safer inductive system. Apparently sensible of this, Mr. Edison does not hesitate to say:—"My personal desire would be to prohibit entirely the use of alternating currents."

The fact that the shocking accident which has given rise to the present discussion was, in all probability, the result of a direct continuous current, and that the burning of the unfortunate victim may have resulted from a low-tension current used for telegraphic or power purposes, apparently does not deter Mr. Edison from his self-imposed task of proving the low-pressure system to be the only safe one. It is, nevertheless, a common practice of the Edison company to use uninsulated overhead wires for its 220-volt current for the purpose of economizing first cost, although it is well known that such a current is capable of burning a body subjected to it as effectually as in the case of lineman Feeks, provided the skin be sufficiently abraded to diminish the electrical resistance of the subject.

Accepting Mr. Edison's classification of the currents used for electric lighting, let us discuss them as follows:—

> *First*—The low-tension continuous current, with a pressure not exceeding 200 volts, used for incandescent lighting.
>
> *Second*—The high-tension continuous current, with a pressure of 2,000 volts and over.
>
> *Third*—The high-tension semi-continuous, or pulsatory, current, with a pressure of 2,000 volts and over.
>
> *Fourth*—The alternating current, with a pressure of from 1,000 to 3,000 volts and over.

The first is not dangerous when a person comes into momentary contact with one wire, but no one can endure its passage through the body when the contact is made "in the most effective manner." I have witnessed the roasting of a large piece of fresh beef by a direct continuous current of less than one hundred volts within two minutes. Any one having access to electric lights operated by the low-tension underground system in New York can easily prove to his own satisfaction how much credence ought to be given to the assertion that a current of 200 volts can be passed through the human body without producing uncomfortable sensations. Let him connect a tin pan to one of the electric wires, and place therein a thick piece of beef, and upon this a gridiron of metal connected to the other wire. The electrical energy exhibited in the steaming and cooking of this beef may possibly surprise the experimenter. If the current is from an underground main, the experiment may be varied by connecting the gridiron to a water-pipe with like results. With even less than one hundred volts it is painful beyond endurance to press firmly with the hands the brushes or any bright brass work of the dynamo, or to grasp any metal connected with the wires.

That a continuous current of moderate tension may produce death when the connection is continued for even a short time is shown by the published record of experiments conducted by A. E. Kennelly at the Edison laboratory. With a continuous current of 400 volts a dog weighing fifty-seven and a half pounds was killed in forty seconds; and in another instance, with 1,000 volts of continuous current, a dog weighing thirteen and a half pounds was killed instantly. That an alternating current of one hundred volts, even when effectively applied, does not kill is shown by two experiments on another dog. A continuous current of 304 volts was applied for thirty seconds, and then an alternating current of one hundred volts for sixty-five seconds; yet the dog was unhurt. But mark this important fact; the so-called "alternating current" used for these experiments on animals was not the alternating current of commerce, but was an Edison direct continuous current made alternating by a "pole-changer," producing an effect incomparably more dangerous than the true alternating current under discussion, because of the exaggerated tension resulting from the partial discharge of the field magnets of the dynamos, which act in this case like a Ruhmkorf coil of enormous dimensions.

The power of destruction residing in the low-tension current under certain conditions is best illustrated by quoting from Mr. Edison's own article, where he says:—

> Near the corner of William and Wall streets, New York, the underground conductors of the Edison Illuminating Co. became crossed, and the current which was passing through them at a pressure of only one hundred and ten volts melted not only the wires, but several feet of iron tubing in which they were incased, and reduced the paving-stones within a radius of three or four feet to a molten mass.

He adds:—"This system is so arranged that consumers are not affected by such accidents as these." But it is, nevertheless, true that every consumer is directly connected to the mains, so that it is evident that the reverse of this statement would have more truly represented the actual possibilities of the case.

Concerning the three other conditions of current referred to by Mr. Edison, he classes them, and rightly so, as dangerous to life, although momentary contacts have repeatedly been made with wires carrying 1,000 and even 2,000 volts of each of these currents, without fatal results. In fact, there have been hundreds of cases in which momentary contact with an alternating current of 1,000 volts and over, as well as with pulsatory and continuous currents, has resulted only in painful shocks, unaccompanied by permanent injury.

The reader of Mr. Edison's article who is unfamiliar with the alternating system of distribution would naturally infer that in practice the same voltage is carried on the house wires as on the mains, as in the Edison system; but such is never the case under any circumstances. In this complete disconnection of the street and house wires is found the reason of the positive safety both to life and property enjoyed by the users of the alternating system. It is one of the great advantages of this system that it admits of the use of high voltages for the street mains, and of wholly separate and independent currents, with absolutely safe voltage, for all wires within buildings—a condition which is infallibly secured and maintained by converters, or transformers, located in or near each building. Each transformer of electric energy is composed of two separately-wound and insulated coils, one of thin wire connected to the street mains, and the other of thick wire connected to the wires of the building. One of the most beautiful features of the alternating system is that when currents of electricity are sent back and forth with almost inconceivable rapidity through the coil of thin wire, there is induced in a neighboring coil of thicker wire an equivalent amount of electrical energy, but at the same time so modified that the voltage, which may be 2,000 in the thin coil, need be only 50 in the thick coil, the volume of electricity being as many times increased as the pressure or voltage is diminished. A current of 50 volts is used in practice, as it is now well established that lamps of this capacity are far more durable and give a better light, with much greater economy, than the 100 or 110-volt lamps. The two coils being absolutely separated from each other by effective insulation through which the current in the primary wire cannot possibly penetrate, it follows that the alternating system has an enormous advantage over the direct system in respect of absolute safety to the consumer.

It seems possible that the time is not far distant when the regulations governing the distribution of electricity will rigidly prohibit direct electrical connection between the street wires and the local service wires inside houses, thereby excluding from dwelling places all the dangerous effects possible to ensue from accidental leakages in the underground system.

The forebodings of Mr. Edison concerning the results of the leakage of current from the underground mains have perhaps been in great part suggested by difficulties experienced in the working of his own system. The Edison underground lines are made up of a great number of short sections of iron pipe, each containing a copper rod, with a plastic insulating material forced between the copper and the iron. These sections are about sixteen feet long and are laid in trenches, and united at the joints like gas-pipes. These pipes are usually laid above the frost line, and are necessarily affected by changes of temperature, which cause the iron pipes to move at the joints. It is, therefore, not unusual to find that after a short time the electrical leakage becomes sufficient to light a number of lamps when connection is made between a water pipe and one of the mains—a fact well known to insurance inspectors. The Edison company continues to use this system, although cables are now made capable of withstanding 2,500 volts of either alternating or direct current with even greater security than Mr. Edison has been able to provide for the 220 volts employed in his low-tension system.

One of the most perfect cables of to-day is a copper wire covered with a thick insulation, over which lead is pressed with very great force, thereby expelling air and gases, and solidifying the insulating material between the lead and copper. There is then woven upon the lead a textile envelope saturated with a water and gas-proof compound. The continuous sections of this cable reach from one man-hole to another, a distance of several hundred feet, and can easily be drawn in and out of the ducts provided for them. Where one piece of cable is joined to another, an electric connection is made and well insulated, then encased in lead, which is afterward soldered to the ends of the respective cables. A cable of this character is uninfluenced by changes of temperature and is subject to little deterioration. To guard against its being pierced by a spark of static electricity, a very simple device is attached to it, offering an easier path for the electricity than through the insulation.

One of the differences alluded to, as existing between the low-tension, continuous-current underground system and a gas-pipe system, is that with reference to leakage.

A gas leak is local and incapable of producing effects at a distance. With electricity, however, the aggregate effects of all the leakages from an underground system may be suddenly concentrated at any point within that system, as by one of the house wires coming in contact with a metal pipe, and such a contact may result even from the work of a mouse; whereupon the leakage of the entire net-work, which may amount to a large percentage of the total current, will be concentrated, and the surrounding material affected (although perhaps to a less degree) in the manner described by Mr. Edison in the reference to the currents at the corner of William and Wall streets.

The interconnection of the conductors for the purpose of reducing the original investment has, in another important respect, a contrary effect from the meshing of gas mains. In the case of the latter, the fracture of a pipe at one place, while it may cause a considerable leak, does not necessarily extinguish the lights of all the consumers. The grounding of one of the wires of an underground circuit, however, affects the entire mesh-work; and a cross between the wires may extinguish the lights of an entire district for a considerable time.

As to the accidents from electric currents, the records of deaths in the City of New York show that there were killed by street cars during the year 1888, 64 persons; by omnibuses and wagons, 55; and by illuminating gas, 23; making the number killed by the electric current (5) insignificant compared with the deaths of individuals from any of the other causes named. The placing of the wires underground would eliminate many of the causes of accidents from electric currents, and they may all be prevented by the employment of reasonable and well-understood safeguards. Mr. Edison's statement that the putting of the wires underground will, instead of diminishing, increase the danger to life, is little less than amazing, at least when considered in connection with his advocacy of his own underground system. The repeated and violent explosions of gas in the man-holes of the Edison system, and in connection with the underground systems of the telephone and telegraph companies, have certainly shown that electricity from any source, either from low-tension electric light, telephone, or telegraph currents, either of which is capable of producing a spark, may be the cause of a serious catastrophe, although there is no doubt that the accumulation of explosive mixtures within these chambers can be effectually prevented. Inasmuch as Mr. Edison's arguments against underground wires generally are equally applicable to his own system, it would seem, logically, that, if his views are to prevail, all electric wires must cease to serve the public. The experience of the cities of Chicago and Philadelphia in the use of underground cables for high-tension currents, to say nothing of the large number of cables laid underground in Rome, Berlin, Milan, and in other cities, indicates that the success of properly-constructed underground systems, whether for currents of high or low tension, has been established beyond question.

There is one radical difference between the alternating and the continuous low-tension system which should be fully understood. It has been shown that in the alternating systems the street mains are absolutely disconnected and detached from the house mains, while the low-tension system necessitates the meshing of all underground mains into one net-work and the supply of the current to that system by a series of feeders. In fact, it necessitates at times the supply of an enormous electrical energy to supply the demand. With the alternating system the practice is not to mesh the wires, but to run independent pairs of wires connecting the switch-board in the station with the thin wires of the converters. These wires are designed to supply only about 1,500 to 2,000 lights per pair, and are made of such a size that there is no appreciable decrease in the lights at the farther end, even if there is a very large consumption of current. Each of these pairs of mains can, therefore, be provided at the station with safety devices which will instantly and automatically cut off the current in the event of a cross-connection taking an abnormal current from the dynamo. Such safety devices cannot be made available with the low-tension system.

Mr. Edison is, moreover, unfortunate in his reference to the use of electric currents abroad. Under the British Electric Lighting Act of 1888 the Board of Trade has issued a set of regulations. Concerning high-pressure conductors it says:—

> 9. *High pressure conductors to be insulated.* Every high-pressure aerial conductor must be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation must not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000.

It will be seen that these regulations provide not merely for 2,000 volts, which is double that used in the American alternating system, but for any voltage whatsoever which the electric companies may desire to carry.

In a recent authorized publication it is stated that the main characteristics of the Edison system are as follows:—

> *First*—Subdivision of generating units to secure reliability and economy of production.
>
> *Second*—Meshing of distributing conductors in a common network throughout the entire area to be supplied, to secure uniform distribution.

Third—A system of special feeding conductors to apportion equally the supply of energy to the demand throughout the area covered by the system of conductors.

Fourth—A system of indicators to denote in the station variations of pressure at any point in the area of consumption.

Fifth—A system of regulation to compensate for any variation of pressure.

The main characteristics of the alternating system contrast with these in a marked manner. These characteristics may be stated as follows:—

First—Large generators located in central stations at points convenient for coal and water supply, and away from residences.

Second—A series of mains running from the station, each set of mains having a capacity of not exceeding 1,500 lights, and each pair of mains extending to the station, so that the lines are only interconnected at the switch-board in the station.

Third—By reason of the limitation of the number of lights on each circuit, the leakage on any one circuit is reduced to a minimum.

Fourth—The interruption or burning-out of any one circuit can have no effect upon other circuits, the contrary being a most serious defect in a system wherein the wires are meshed.

Fifth—Absence of numerous and costly regulating contrivances.

Sixth—Ability to use within all houses a 50-volt current, whereby the most efficient lamps can be utilized.

Seventh—Absolute separation of the street mains from the house mains, thereby preventing injury or danger from the leakage from the street mains.

Eighth—The use of a mechanical meter, which accurately records the entire electrical energy consumed in the house.

Ninth—The easy regulation of the current if required, so that the lights may be turned up and down without expensive and wasteful machinery.

There is not on record a solitary instance of a person having been injured or shocked from the consumers' current of an alternating system. This is wholly due to the fact that the converted current within the buildings supplied need not exceed 50 volts, and that the street mains and the house wires are absolutely detached from each other, so that there is no possibility of a shock being received from leakage or short-circuiting in the high-tension street mains.

The fire risk from electricity is the one most to be feared. With the continuous current, whenever there is occasion to put out a number of lights by the movement of a switch, it not infrequently happens that a dazzling arc of blue flame is formed which has to be blown out. With the alternating system it is impossible to form any considerable arc, even if the switch controls a thousand lights, the rapid reversals of the current having the effect of preventing its establishment.

Mr. Edison's observations concerning the efforts of his competitors in the direction of saving in investment are no less applicable to the desires of the suppliers of his own system. At the annual convention of the Edison Illuminating companies at Niagara, in August of this year, the following resolutions were offered by Mr. Gilbert, of the Detroit Edison station :—

Resolved, That the Association respectfully call to the attention of the Edison General Electric Co. the difficulties under which local companies are now laboring in consequence of the lack of

1. An efficient and inexpensive arc light system.
2. An arc lamp which can be economically operated on the three-wire system.
3. A flexible method of enlarging the territory which can be profitably covered from their stations for domestic lighting *by higher pressures* and consequently *less outlay of copper* than that involved by the three-wire method.

We earnestly appeal to the parent organization to supply these deficiencies.

The proceedings of the convention also contain the following:—

The address of Sir William Thomson, as president of the physical section of the British Association in 1882, contained this memorable passage:—"Nothing above 200 volts, on any account, ever should be admitted into a ship or house or other place where safeguards cannot be made absolutely and forever trustworthy against all possible accident." This opinion accords with what Mr. Edison has always maintained—that in the long run every system will fail which does not (for domestic service) use a low-pressure current.

This is precisely what the alternating system supplies. The successful use of arc lamps depends upon high voltages. Neither Mr. Edison nor any other person has yet been able to supply the requirements of the public by means of a low-tension arc lighting system.

A careful consideration of the whole subject proves that it is possible to light all the buildings within a city by means of electricity distributed by an underground system, wherein there shall be no connection whatever between the underground system and the wires within the buildings. It has been demonstrated that an incandescent lamp operated by a 50-volt current will give more light at a given cost than a 110-volt lamp; and, these two things being admitted, it follows that, if there are to be any restrictive regulations with reference to electric lighting, they might more properly be: *First*—That the electromotive force within any building shall never exceed 100 volts; *Second*—That no underground system shall be placed in electrical connection with the wires in the buildings; *Third*—That no underground system shall be permitted which does not provide for the renewal and repair of the mains without digging up the streets.

In conclusion, it is worthy of note that for three years past the purchasers of apparatus for electric lighting, who are at perfect liberty to buy from any company, have, for the most part, preferred to use the alternating system, so that to-day the extension of that system for central station incandescent lighting is at least five times as great as that of the direct current. If the opinion of these persons, who can have no interest except to purchase that which they believe to be the best, is of any value, then the alternating system has been demonstrated to be the one which can give to the public that which they so much desire—a safe, cheap, efficient, and universally applicable system of incandescent electric lighting.

POINTERS.

.... It is not so much what is received or earned, as what is saved of those earnings, which counts in the long run.—*C. C. Haskins.*

.... At the present time, with competent, careful and intelligent men in charge of central stations, there is absolutely no danger from the use of high-pressure currents that calls for any change from the present system.—*B. E. Sunny.*

.... The immediate demand in our large cities is for installations of hundreds of thousands of horse-power, instead of those of a few thousand horse-power merely.—*George Cutter.*

.... In my opinion, the true interests of science are suffering from the baneful influence of the government monopoly, which is not a monopoly of telegraphs simply but of electricity and science generally.—*S. Alfred Varley.*

.... It is not alone the larger expenditures which serve to dissipate and fritter away the receipts of any industry. There are numerous smaller expenses which, like the mice in the fable, gnaw many minute holes in the bin and cause large leaks in the aggregate.—*C. C. Haskins.*

.... The record outside of the City of New York, where proper methods have been adopted and a reasonable amount of room could be secured, has been practically free from electrical fatalities during the last three years.—*B. E. Sunny.*

.... More people were killed by teams in the streets of New York and Brooklyn in the last two years than have been killed by electric currents in the whole history of the world.—*George Cutter.*

.... What the mathematician has been doing for the most part has been simply examining and microscopically measuring, with mathematical spectacles, the edifices raised by the engineers of the earlier period. The nearest approach to anything original they can be credited with, is simply designing measuring instruments, and even in such work our mathematical men are much more indebted to the intelligent mechanic than they are disposed to admit.—*S. Alfred Varley.*

ABSTRACTS AND EXTRACTS.

COMPARISON OF THE INTRINSIC INTENSITY OF SOLAR RADIATION WITH THAT OF THE ELECTRIC ARC IN DIFFERENT PARTS OF THE SPECTRUM.

[Extract from a paper on "The Temperature of the Moon," by S. P. Langley, with the assistance of F. W. Very, in *American Journal of Science*, vol. xxxviii., December, 1889.]

This observation of the comparative intensity of the sun and the electric light is given in the original memoir only so far as to show that it brings independent evidence of a large atmospheric absorption of the extreme infra-red rays and enables us to estimate approximately the amount of this absorption at each point in the spectrum. The observations were not repeated to obtain such a thorough comparison as would be desirable. As they have never been printed, however, and since, as far as we know, none other such exist, we will give them here under the caution that they are to be considered only first approximations. The light was that from the pit of the positive carbon of gas coke, one inch in diameter, with the current derived from a dynamo, actuated by an engine of 10 h. p., and therefore certainly at least as intrinsically hot and bright as any smaller arc light in more common use, and presumably much more so. The apparatus was that already described in the memoir "On Hitherto Unrecognized Wavelengths." [See description of galvanometer below.]

The following table gives the observed galvanometer deflections after applying a multiplying factor for the shunt, which had to be used for the larger readings:—

1 Deviation rock salt 60° Prism.	2 Wave-length.	3 Observed deflection *sun* after absorption	4 Observed deflection *arc*.	5 Calculated deflection *sun* without absorption.	6 Observed ratio sun and arc.	7 Calculated ratio of unabsorbed sun and arc.
° ′	μ	div.	div.	div.		
43 53	0.373	7.5	1.3	34.	5.77	26.0
43 17	0.398	11.5	1.5	38.	7.67	21.8
41 54	0.489	33.5	5.3	60.	6.32	14.4
41 05	0.587	104.0	10.5	115.	9.90	11.1
40 45	0.663	204.0	22.0	204.	9.27	10.0
40 27	0.749	432.0	43.5	450.	9.93	9.1
40 05	0.96	1 073.0	215.0	1 763.	4.99	8.2
39 54	1.13	1 783.0	459.0	3 534.	3.88	7.7
39 20	2.87	1 905.0	882.0	5 645.	2.16	6.4
39 00	4.3	521.0	235.0	1 363.	2.22	5.8
38 45	5.6	75.0	157.0	832.	0.48	5.3
38 00	10.4	19.5	39.0	156.	0.50	4.0

The result of the comparison of the (of course, unabsorbed) electric arc with the radiation of the sun after absorption, as shown in the sixth column, is that this solar radiation in the orange and red is nearly ten times that of the arc, while towards the violet end of the spectrum, the relative superiority of the absorbed solar heat diminishes, evidently because of the progressive increase of the atmospheric absorption in that direction, which lessens the solar intensity without sensibly affecting that of the arc. The solar efficiency continues greater through all the infra-red spectrum known until very lately, while in the extreme portions recently investigated, it falls below that of the arc. This is partly due to the fact that radiation from a source at a lower temperature (the arc in this case) is relatively more powerful in the longer than in the shorter waves; yet it can hardly be doubted that here also (that is, in the *extreme* infra-red) a very large atmospheric absorption has taken place.

There is reason to believe that a considerable part of this absorption takes place in the first few meters of air, while we conclude, from all the evidence in our possession, that the real telluric absorption, being a locally selective one, is much greater than the comparison of high and low altitude observations alone would indicate.

The import of this comparison will be still more evident from a consideration of the seventh column, where by means of the Allegheny tables of the solar absorption, we have calculated the ratio of the arc heat to that of the sun before absorption by the earth's atmosphere. Although a large absorption by the solar atmosphere has already taken place, we see that in the ultra-violet the solar radiation is from 20 to 30 times that of the arc, while that of the absorbed sun is only about 6 or 7 times. When we reach the region of the red and upper infra-red, we see that these ratios are nearly the same in the absorbed and unabsorbed solar radiation, showing that the terrestrial absorption in this region (which was once supposed to be its principal seat), is in fact very small, while in the regions of the extreme infra-red corresponding to temperatures not greatly exceeding that of the terrestrial soil (regions only revealed by quite recent investigation) the telluric absorption again becomes considerable.

The general result of this comparison is to enhance our ideas as to the rate of solar radiation, and as to the solar temperature. Comparisons of the total solar radiation with the total arc radiation have (it may be observed) been made before, but so far as I am aware, comparisons of the heat in different portions of their spectra are here presented for the first time.

Description of Galvanometer Used by Professor Langley.

—From *American Journal of Science*, vol. xxxii., Aug., 1886.

It must be remembered that while the nominal sensitiveness of a galvanometer can be increased to any extent by increasing the astaticism of the needle (quite as nominal power can be multiplied to any extent on a telescope by altering lenses at the eyepiece), that the real or working capacity depends upon the ability to always obtain a like result under given conditions. Accordingly, we have continued to devote great pains to extend our original conception, so as to make the galvanometer, as well as the bolometer, not merely an indicator of heat, but a real "meter," which shall distinctly answer the question "how much?" as to almost infinitely minute amounts of energy.

For the benefit of any physicists who may desire to repeat these experiments, we may observe that we have found the bolometer capable of almost unlimited delicacy of perception of heat, but that our chief trouble has arisen from the difficulty of constructing a galvanometer suitable to develop its full capacity for exact measurement. We have been unable to find among galvanometers ordinarily constructed one capable of indicating with precision changes in the amount of current of much less than $\frac{1}{1000000}$ of an ampere. It was in the construction of a galvanometer, designed to measure the heat in the spectrum of the moon, that we acquired the experience which we have utilized in the present researches.

A reflecting galvanometer, of the form devised by Sir William Thomson, has been used for the basis of our construction, and altered as follows. (For several of the changes described I am indebted for suggestions due to the great kindness of Sir William Thomson and Professor Rowland.) First, the short suspending fibre supplied by the makers has been replaced by one 33 cm. in length, stretched and prepared with particular care. Next, since the effect of a given minute change of current is proportional (other things being equal) to the magnetic moment, and to the minuteness with which the angular deflection of the needle can be read, we have reconstructed the mirror and needles as follows: For the magnets,[1] soft sheet steel $\frac{1}{20}$ of a mm. thick, is rolled up into minute hollow cylinders each about 8 mm. long and about 1 mm. diameter. These are hardened and made to take a permanent charge of nearly 900 Gaussian units. Ten of these are placed behind the back of the mirror and ten below, making twenty in all. The reflecting mirror is accurately concave, being specially worked for the purpose, 9.5 mm. in diameter, 1 meter radius of curvature, weighing 63 milligrams, and platinized on the front face by the discharge *in vacuo* of platinum electrodes, through the process of Professor Wright,[2] of Yale College. The stem which unites the upper and lower system of the magnets is a hair-like and hollow tube of glass, while it occurred to me to replace the aluminum vane of the ordinary instruments, by the wings of a dragon fly (*Libellula*), in which nature offers a model of lightness and rigidity quite inimitable by art.

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[1] The design and construction of the hollow magnets is due to Mr. F. W. Very, of this observatory.

[2] Professor Wright has had the goodness to platinize these delicate mirrors for us himself.

The glass plate which encloses the front of the galvanometer has optically plane and parallel sides, and the screen, placed at one meter distance from the mirror, is a portion of a cylinder one meter in radius, divided into 500 divisions of 1 mm. each. The optical arrangements for illuminating and forming an image of the wire form one of such precision that a motion of $\frac{1}{10}$ of one of these divisions can be distinctly noted. There is an independent provision, by means of which the image of a second opaque and inverted scale can be viewed by the observer through a telescope, not as in the ordinary construction, directed on to a flat, attached to the needles, but in which the concave mirror, already described, becomes itself the mirror of a Herschelian telescope. Ordinarily the condition of astaticism of the needle is such that without any damping magnet, it will execute a single vibration in not less than 15 or more than 30 seconds. Much greater sensitiveness can be given to it, of course, but without, as we have found, corresponding advantage.

For the purpose of forming an estimate of the sensitiveness of the instrument, it may be stated, that when making a single vibration in 20 seconds a deflection of 1 mm. division of the scale is given by a current of 0.000,000,000,5 amperes through the coils of 20 ohms resistance; and, as we have just remarked, a tenth of one of these divisions can be discriminated. That this degree of sensitiveness is associated with a real, and not nominal, corresponding degree of accuracy, is shown by the fact that many series of accordant measurements have been made when the maximum deflection did not exceed three such divisions; and that similar measures have been made in the invisible spectrum given by ice melting in a dark room, when the maximum deflection observed was 1.6 mm. and most deflections less than one millimeter. On the other hand, the exposure of the same bolometer to ordinary direct sunlight with only $\frac{1}{1000}$ of the current passing, *i. e.*, with the galvanometer shunted 1,000 times, would drive the needle immediately, and with violence, off the scale.

Our experience has shown us that this galvanometer, in conjunction with such a bolometer as we have described, is capable of recording a disturbance of rather less than $\frac{1}{10000000000}$ part. To attain corresponding accuracy in gravity determinations we should need to have a balance capable of weighing a kilogram which would give at the same time an unequivocal deflection for a difference of one one-thousandth of a milligram in either pan. A deflection of 1 mm. corresponds, in the case of such a bolometer as we have used in the lunar spectrum, or in that of melting ice, to a change of temperature in the bolometer strips considerably less than $\frac{1}{100000}$ of a degree Centigrade, and we have just seen that about $\frac{1}{10}$ of this can be shown. In other words, about one-millionth of a degree can be indicated by it, and a quantity less than one hundred thousandth of a degree not only indicated but measured. It will be obvious to the practiced observer, that this degree of accuracy will not be in reality reached, unless the bolometer strips are perfectly protected from all extraneous radiations and air currents, and especially unless the image is fixed upon the scale when the bolometer is not exposed to heat. This degree of precision we believe ourselves to have actually obtained.

ON THE ELECTRIFICATION OF A STEAM JET.[1]

BY MR. SHELFORD BIDWELL, F. R. S.

THE author showed that the capacity of steam issuing from a nozzle is greatly increased by bringing electrified points near it, and that its color is changed to orange-brown. Electrified balls and discs when placed in the steam produce similar effects, and when these are connected with an influence machine at work, the decoloration of the jet rapidly responds to each spark. On examining the absorption spectrum of the unelectrified jet, little or no selective absorption was detected, but on electrification the violet disappeared, the blue and green were diminished, and the orange and red remained unchanged. From these results the author concludes that electrification causes an increase in the size of the water particles in the steam, from something small, compared to the wave length of light, to about $\frac{1}{50000}$ of an inch in diameter. Allied phenomena with water jets have been observed by Lord Rayleigh, who found that a straggling water jet is rendered much more coherent by bringing a rubbed stick of sealing wax near it. These observations are of considerable meteorological interest, for the steam jet phenomena go far towards explaining the cause of the intense darkness of thunder clouds, and of the lurid yellow light with which that darkness is frequently tempered. After making his experiments, the author learnt that similar observations had recently been made by the late Robert Helmholtz, who viewed the steam jets by reflected light against a dark background. On electrification the jets became much better defined, and presented diffraction colors. Luminous flames also produced similar effects, and Mr. Bidwell has found that glowing touch-paper is equally efficient. Helmholtz conjectures that the sudden condensation may be due to molecular tremors or shocks imparted by the electrification upsetting the unstable equilibrium of the supersaturated vapor, just as a supersaturated saline solution is suddenly crystallized when disturbed. Another hypothesis suggests that condensation is caused by the introduction of solid matter into the jet by the exciting cause, thus providing nuclei upon which the vapor may condense. On reading Helmholtz's paper, the author tried the effect of gas flames on water jets, and found that when luminous they influenced the jet considerably, whereas non-luminous flames had no appreciable effect. He also found that luminous flames are positively electrified, and demonstrated this before the meeting.

Professor Rücker, in discussing the paper, said that he thought the surface tension of the films surrounding the water jets would be modified by the presence of an electrified body, and that the smoke from the touch-paper used in some of the experiments on steam jets would introduce solid particles and facilitate condensation. Mr. Richardson inquired whether a red-hot iron had any effect. Dr. Fison said he had made experiments on the electrification of flame, and found that potentials varying from + 2 volts to — 1½ volts could be obtained in the region within and surrounding a Bunsen flame. Professor S. P. Thompson commented on the contrast between Mr. Bidwell's experiments and those of Dr. Lodge on the dissipation of fogs by electricity, and also asked whether the color of the jet depended on the length of spark produced by the machine. Professor Forbes thought a crucial test between the two hypotheses of Helmholtz could be obtained by trying the experiment in a germless globe. The president, Professor Reinold, said he had recently noticed that gas flames were electrified. Mr. Bidwell, in reply, said he ought to have mentioned that the effect of flames on jets may be due to dirt, for if soap or milk be added to the water in the steam generator no effect is produced by electrification or flame. As to change of color with spark length, little, if any, variation is caused thereby. He had not tried whether a red-hot iron produced any effect on a steam jet.

ELECTRIC TRAIN LIGHTING IN AMERICA AND EUROPE.

AMONG the numerous papers read before the International Railroad Congress, recently held at Paris, was a report on the use of electricity, written by E. Sartiaux, chief engineer to the telegraph department of the Northern Railroad of France, and L. Weissenbruch, engineer to the Belgian post and telegraph department.

This paper treats of the present applications of electricity to railroad service, under three divisions; *i.e.*, lighting trains, lighting stations and working brakes. This is an interesting paper from a European stand point, and has some points of interest to the railroad men of the United States particularly that portion referring to train lighting. The results of trials of electric lights on railroad trains in the United States are mentioned in the paper. Regarding the cost of electric lighting, compared with that of gas and oil in trains, the joint authors have come to the following conclusions :—

1. That the cost of electric lighting by accumulators alone, charged at fixed stations, varies in the United States from 5 centimes to 5.6 centimes with lamps of from 12 to 16 candles, and that in Europe the cost is from 1.9 to 3 centimes for lamps of from six to eight candles, per lamp-hour
2. From experience obtained in Europe it is possible to charge accumulators by a dynamo driven off the axle at a cost not exceeding 4 or 5 centimes per lamp-hour for 5-candle lamps.

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[1] Abstract of communication read before the Physical Society, London, December 6, 1889.—From *Industries*.

3. That in the United States the cost of lighting varies between 3.5 and 5 centimes per lamp-hour for 16-candle lamps in installations comprising accumulators, dynamos, and an engine supplied with steam from the locomotive.

On the continent the cost of Pintsch gas per lamp-hour (five or six candles) is 3.764 centimes, and of colza oil, 5.635 centimes. It will be seen that for lights of the same candle-power, gas would therefore cost about 11.8 centimes per lamp-hour, and oil about 16.9, as against 5.6 for electric lights; but really these deductions are based upon too few experiments to render the comparisons reliable.

The authors further say:—"It is impossible to consider the present condition of electric train lighting without being struck with the very considerable progress that has been made in the last few years; electricity comes very near meeting the requirements of the case, both as to the cost of maintenance and as to the beauty and intensity of the light. The almost entire absence of heat, the steadiness of the light, and the facility with which it can be placed at any desired point of a car or compartment, certainly make it preferable to any other mode of lighting, if it is desired to be able to read a long time without fatigue.

"The arrangement which appears to be most advantageous, is to place accumulators under or on each car, a single group for all the lamps, or a separate battery for *each lamp*, these accumulators being charged at fixed points, either with or without removal from the train. The weight of the accumulators necessary for 22 lamps in a car is about 1,100 pounds. (This is no more than that of the Pintsch gas apparatus, which varies from about 1,000 to 1,300 pounds per car, as stated by Mr. P. Lefavre in a report on the dead weight of trains.)

"Where for particular reasons, it is necessary to dispense with this additional weight, it is still possible to light successfully trains which are not to be broken up, by a dynamo placed in the baggage car and operated from an axle or by steam from the locomotive. When this latter plan can be combined with the heating of the train by steam, it seems to be a very economical method. The experiments in the electric lighting of trains are, however, so recent, that notwithstanding the importance of the results obtained, none of them are conclusive." The authors finish their report by recommending to the different railroads further experiments in this direction.

In our own country progress has been made principally in the direction of lighting by a dynamo and engine in the baggage car, supplemented by accumulators under each car, which are kept charged by the dynamo running in the day time as long as may be necessary. This arrangement seems to give the most satisfactory results, though it has yet been applied only to a few luxurious trains which are never broken up, and which run for long distances. It remains to be seen whether it can be made practically successful on trains of the usual character. Thus far it has been found necessary for a competent electrician to accompany each train, the apparatus requiring too much care to be put in charge of any of the trainmen in addition to their other duties.

The Intercolonial Railway of Canada has, however, continued experiments with accumulators alone, they being charged at three different points on its line, and running about 500 miles with one charge, when they are replaced by a fresh set. The number of 16-candle-power lamps in each car varies from 11 to 22, and more than 40 cars have been fitted with electric lighting. In the number of cars lighted, this road is equaled or exceeded by but one or two in America. The results obtained, are, on the whole, favorable, but the electric light is not exclusively depended on, the oil lamps having been retained in all these cars, and it may be said, frequently used. A fourth charging station is now being built, to save the necessity of sometimes extinguishing the electric lights on the return trip, owing to the charge in the accumulators having become exhausted.

The Boston & Albany Railroad has lately discontinued the use of electric lights on the limited express trains between Boston and New York, and substituted Pintsch gas. This step was taken partly because of the great expense attending the use of electricity (the accumulators being charged by electric lighting companies at either end of the line), and partly because of a considerable number of cases where the lights failed altogether or were unsatisfactory. It was precipitated by the suspension of electric service in New York city, rendering the use of the oil lamps necessary on one trip each day in one direction in such of the cars as were supplied with them.

The drawing-room cars were fitted only with electric lamps; hence these were in darkness, and after the second day were withdrawn from service, until they could be fitted with gas lamps.

Attempts were made, it will be remembered, for a few months in 1887, on the Connecticut River Railroad, to run a dynamo from one of the axles of a baggage car, but after successive trials of transmissions by belts, ropes and chains, it was abandoned as impracticable, and there have since been no experiments of this kind on this side of the Atlantic. The reason of its success abroad lies in the fact that the cars there have but a single pair of wheels at each end, and because of the few curves and high speed of trains on the principal lines. In all these installations, the direct source of supply for the lamps is a battery of accumulators, located either in the baggage car or distributed through the whole train. The function of the dynamo is to keep these fully charged. An automatic switch is also necessary to cut off the connection between the dynamo and accumulators whenever the speed falls below a certain limit, else the accumulators would discharge themselves through the dynamo and possibly ruin it, besides greatly injuring themselves. Skilled attendance is also advisable, and in many cases absolutely necessary.

Electric lighting of cars in America, must, therefore, be considered at present a luxury, to be used on a few trains in exceptional circumstances, and not yet developed either in appliances or in cost, to a point where it can compete with oil or gas for every-day use. But as the luxuries of one generation become the necessities of the next, the beauty, comfort and healthfulness of the electric light may yet make it indispensable to all first-class railroads, and inventive genius will yet produce apparatus for generating it, which is convenient, reliable, and cheap.

The Swiss Railway Union, at a meeting on Nov. 2 last, passed the following resolution: "That, considering the actual position of electric lighting, it is not desirable to extend the lighting of trains by gas, but that it is preferable to continue the investigation of the electric lighting problem, and to extend experiment." Experience in this country will hardly warrant so strong a statement, but further investigation is certainly needed before a final determination.—*Railroad Gazette.*

RAILROAD SIGNALS AND SIGNALING.[1]

At the meeting of the New England Railroad Club at Boston, December 11, Mr. R. H. Soule, of the Union Switch & Signal Co., delivered an interesting address on the above subject, from which we make extracts below.

Beginning with a brief historical sketch of the art in this country, with allusion to the important features inherited from English practice, Mr. Soule continued:—

The semaphore has been referred to as the best form of visible signal. This is certainly true for all signals that are approached at high speed, and must be seen from a distance. Custom has prescribed that home signals should be painted red and distant signals green, although at least one large system in the west has adopted yellow as the standard color for all semaphores; the claim being that the semaphore is merely a position signal, and that therefore it may be of that color which will be most effective, and will make it visible from the greatest distance under adverse conditions. It may be confidently stated that when other forms than the semaphore are used as high-speed signals, the reason lies either in the desire to use a cheaper signal, or in the fact that the motive power used to work the signal is not sufficient to overcome the inertia of the semaphore in starting or to resist its momentum in stopping. It is for this latter reason, probably, that the semaphore is not used where the propelling force is a weight, which is made active through the instrumentality of an electric current and an electro-magnet. This applies principally to high-speed signals; for low-speed signals to govern shifting operations, or what are known as reverse movements, it has hitherto been customary to use a low down disc signal, commonly termed a pot signal; but more recently there is a marked tendency towards the use of dwarf semaphores for this purpose. The almost universal custom in this country is to hang the semaphore blade so that it will point to the right when viewed from an approaching train which it governs. The Boston & Albany is the most notable exception. Some effort has been made to secure the successful introduction and use of position signals by night. The Boston & Albany accomplishes this by the expedient of equipping each semaphore signal with three lights, so connected that when the blade is in the horizontal, or danger position, two lights, in the same horizontal line, are displayed, while with the blade hanging down, in the clear position, two lights, in the same vertical line, are displayed. More recently, on other roads, illuminated semaphores have been devised and introduced.

Referring to compensators and the difficulties incident to their use, the speaker said:—

In general they were expensive, and sometimes dangerous, as when a certain one of the two wires broke, in which case the signal might be left in the clear position; it subsequently developed that with two wire connections it was entirely practicable to omit all automatic compensating devices, and such is now the very general practice. Both wires are fitted with adjusting screws, which need to be used only between extremes of temperature; ordinary slight variations of temperature result in no movement of the signal blade, as both wires are affected equally; neither are the wires thus subjected to any undue strains; in their natural condition they are full of kinks, which give and take enough to more than accommodate the alteration of length due to changes of temperature such as occur in practice.

The principal of preliminary interlocking was formulated as

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1. From the *Railroad Gazette*, December 13, 1889.

follows: "A lever which is to lock certain levers and release certain other levers must complete all its locking functions before the beginning of its stroke, and must not accomplish its releasing or unlocking functions until after its stroke is completed." Mr. Soule continued: the spring catch affords the means by which it is possible to meet these conditions, and it is now invariably used to actuate the interlocking mechanism; this is common to all successful machines, although the means by which it is accomplished may differ. The following original rules for interlocking were formulated in 1876, and are believed to be sufficient for present guidance.

I. Each home-signal lever, in that position which corresponds to clear signal, must lock the operating levers of all switches and switch-locks which, by being moved during the passage of a train running according to that signal, might either throw it from the track or divert it from its intended course, or allow another train (moving in either direction) to come into collision with it.

II. Each lever so locked must, in one of its two positions, lock the original home-signal lever in its danger position; that position of lever being taken which gives a position of switch, or switch-lock, contradictory to the route implied by the home-signal, when clear.

III. Each home-signal lever should be so interlocked with the lever of its distant signal that it will be impossible to clear the distant signal until the home-signal is cleared.

IV. Switch and lock levers should be so interlocked that crossings of continuous tracks cannot occur, where such crossings are dependent upon the mutual position of switches.

V. Switch levers and their lock levers should be so interlocked that the lever operating a switch cannot be moved while that switch is locked.

When these rules are followed in practice their mutual bearing, one on another, becomes evident, and it is found to be unnecessary to locate a separate locking dog for each locking process referred to. The practical process of making an interlocking chart becomes an instinctive matter with those who are habitually engaged in that class of work.

Even the excellent Saxby & Farmer machine has some features which are susceptible of improvement. The Union Switch & Signal Co. have been required to carry 560 different patterns of locking dogs to meet all the cases of exceptional and special locking which have occurred in their practice. By the recent introduction of what is known as tongue-locking, which may be used as an auxiliary to the Saxby & Farmer system, the number of such patterns have been reduced from 560 to 20. The advantage thus gained is being still further pursued, and the company is about ready to introduce a new interlocking machine, from which the old Saxby & Farmer flops and locking dogs have been eliminated. The new interlocking mechanism revives the use of bars with beveled faces, as in the Stevens system, but under such radically different conditions that the rapid wear which characterized the Stevens locking, and seriously impaired its efficiency, cannot occur. The working parts of the interlocking mechanism of the new machine are all of wrought iron, steel or malleable iron, and their durability thus assured.

The tendency of recent practice is toward still greater concentration than had been effected by the mere assembling of switch and signal levers; this applies to the track work as well as the machine and connections. A terminus which has been planned with reference to its control from an interlocking station will, in general, be found equipped with lead tracks of high frog angle and with double slip switches. * * * * Originally separate levers were used for each switch, lock and signal; at the present time it is common practice to work the two switches of a crossover with one lever; if movable frogs are used they may be moved by the same lever; it is now usual to move a switch, its lock and its detector bar by a single lever; as the lock bolt must be withdrawn and detector bar reversed before the switch is shifted, and as both must be restored to normal position again after movement of switch is completed, special and ingenious mechanism has to be employed to accomplish this result from the single stroke of a single lever. A home and a distant signal are often worked by a single lever, a special device being introduced into the connections, which insures the clearing of the home signal before the distant signal is cleared. By holding the lever at midstroke the home signal may be held at clear and the distant signal held at caution. In working signals the introduction of selectors has contributed toward greatly reducing the number of levers required for the operation of an interlocking plant. The principle of the selector is this:—Given a group of signals, only one of which can show clear at a time, then only one lever in the interlocking apparatus need be provided for the operation of those signals; the line of connections from the working lever is led out to some convenient point in the direction of the signals and there terminates in the selector; from the selector run independent lines of connection to the several signals; the function of the selector is to engage the lever connection with one or another of the signal connections, and this is automatically accomplished by the connections to the several switches involved, alongside of which switch connections the selector must be located. The result is, that, when the lever is pulled, that signal is cleared which corresponds to the setting of the switches; in fact, the selector is an auxiliary interlocking apparatus; its application to the connections of a group of signals reduces the number of levers to be handled in the interlocking station, but, in connection with what are known as indicators, the selector may be utilized to reduce the number of signals themselves. An indicator is a device by which one of several diverging routes implied by a signal is designated and defined; indicators generally consist of a set of discs located just below the signal blade and numbered to correspond to the several routes. When the signal is at danger, the indicator discs are concealed behind a screen; when the signal is cleared that disc which designates the route prepared by the switches is elevated into view and brought into range with a lamp placed immediately behind, so that the number on the disc may be observed either by day or night.

The utilization of these several expedients, such as the switch and lock movement, the home and distant signal movement, the selector and the indicator, have made it possible to effect a large reduction in the cost of interlocking plants. Two instances from recent practice will illustrate this. The interlocking apparatus at the Grand Central Station in New York city, as rearranged in 1887, comprised 116 levers. Within two years the change in terminal arrangements and the increase in volume of traffic necessitated a rearrangement of the yard tracks, and the opportunity was taken advantage of to utilize the more modern interlocking appliances and connections. The railroad company decided to introduce 11 additional switches, each of which was to be equipped with a lock, also 29 locks on switches not previously equipped, and 12 additional signals. Had a separate lever been required as formerly for each switch, each lock and each signal, the number of levers would have been increased from 116 to 179, but, on the contrary, the new plant recently put in operation, has but 87 levers, a relative reduction of about 51 per cent.

A still more striking illustration may be had by comparing our present practice, not with our previous practice, but with the English practice of to-day. The Union Switch & Signal Co. recently submitted to Saxby & Farmer a plan of the new terminus of the Central of New Jersey at Jersey City, together with a specification of the signaling required, and a request that they should state the number of levers that they considered necessary to properly operate and interlock the terminus in question. They replied that they would recommend the use of an interlocking frame of 185 levers; but the plant actually established in Jersey City [see *Railroad Gazette*, June 28, 1889] consists of but 66 levers, a relative reduction of about 64 per cent., and yet it accomplishes all that the English plant of 185 levers could accomplish.

If the English and American practice in the case of the Jersey City plant are a fair criterion, then the great London Bridge apparatus, the largest in the world, if rebuilt upon American principles to-day, would be reduced from 280 levers to 100. Over-conservative public opinion has apparently influenced the Board of Trade to place legal restrictions on manufacturers and railways, which debar them from enjoying the benefits and economies of concentration.

Mr. Soule then described electro-pneumatic interlocking apparatus, referring to the first one ever made—that at Philadelphia in 1876. The fluid now used by the Union Switch & Signal Co. in the winter is a mixture of one part chlorate of calcium to three parts of water,

Thirteen of these pneumatic interlocking machines have been put in service during the last five years, and the machine now being put in at Kansas City has 36 levers for the operation of 59 switches, with locks and detector bars, 57 signals, 87 indicators and one set of movable frog. At Pittsburgh, on the Pennsylvania, there may be seen four plants in operation—at Fourteenth street, Seventeenth street, East Liberty and Wilkinsburg. The same supply of compressed air feeds the four pneumatic interlocking plants and the twelve sets of pneumatic block signals.

Having previously described automatic clock-work block signals, Mr. Soule went on to give a brief résumé of block signaling, including the Sykes system, and followed this by an account of the automatic pneumatic block system at Pittsburgh, described in the *Railroad Gazette* of August 23 and September 6 last. The Union Switch & Signal Co. are now introducing this system on seven miles of the Central of New Jersey, between Jersey City and Bergen Point. The road has four tracks for a portion of this distance, and double track the rest; the seven miles will be subdivided into 19 blocks, which will therefore average three-eighths of a mile in length.

In conclusion, Mr. Soule said:—From the facts presented it appears that recent practice in signaling and interlocking has resulted in substantial economies, which have been secured principally by concentration. It would seem difficult to accomplish much more in that direction with manual apparatus, and the outlook for further gain is probably in the extended use of the pneumatic system, which is very efficient either for interlocking junctions and terminals, or for the operation of a system of block signals; the pneumatic method possessing distinct and decided advantages for lines which have a heavy traffic.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Resumption of Traffic by the Storage Battery Cars on Fourth Avenue.—The Fulton Street Electric Railway.—Danger from Low Tension Currents.—The New York Electrical Society.—The Commercial Telegram Company's Main Office in the Sheriff's Hands.—The Mc.Dougal-Martin Electric Company.—Rumored Preparations of the Bell Telephone Company to Fight for the Telegraph Business.—Wholesale Destruction of Electric Light Lines by the Department of Public Works.—Removal of J. H. Bunnell & Co.

THE resumption of traffic by the storage battery cars on Fourth avenue was an agreeable surprise to those who have been watching the gradual supersedure of horses, upon the only line in the city where electricity has gained a foothold. The number in operation will be gradually increased as the cells are prepared, under the process permitted in the decision of Judge Lacombe.

It is reported that the franchise of the Fulton street electric railway is offered for sale, but there are no purchasers. The reason for this lack of interest is supposed to be the fact, that under the terms of the charter 35 per cent of the gross receipts were to be turned over to the city treasury. The rails and electric conduit remain in position but have never been utilized.

In Mr. Edison's recent article in the *North American Review*, the admission was made that low tension currents might cause intense heat, even if they did not destroy life. It is well known that this danger has been carefully guarded against by the careful construction of the Edison system. This caution has not however been exercised by other companies, and the daily newspapers have suddenly discovered, and are making the most of the fact, that currents of low voltage may cause fire. Owing to the sensitive condition of the public's mind, it appears probable that there may be an outcry against electric wires of all descriptions, which will be generally detrimental to electrical industry.

The meeting of the New York Electrical Society, December 11th, proved to be the most interesting and best attended of the season. Mr. S. Dana Greene addressed the meeting, on the "Development of Street Car Traction." He was followed by Mr. Frank J. Sprague, who believed the electric railway had nothing to fear from the introduction of the cable system.

The main office of the Commercial Telegram Co., at 18 Broadway, has been taken charge of by the sheriff, who levied upon the property to satisfy two judgments, one in favor of J. W. Mackay for $287,312, and the other for $32,120 in favor of E. C. Platt. It is said that the company's plant will be sold within a short time.

Up to this writing, the State Electrical Executioner has made no report to the daily *World* of the amount of his receipts in ten-cent subscriptions, which were to be devoted to legal services in behalf of the public against the electric lighting companies.

The McDougal-Martin Electric Co., recently organized, will devote its attention principally to motor work. Mr. McDougal was formerly superintendent of the Daft factory at Marion. Mr. C. W. Price, who is interested in the company, was also with the Daft company at the New York office, 115 Broadway.

The New York *World* has devoted a column each day for about a week to showing how the American Bell Telephone Co., through the American Telephone and Telegraph Co., was gradually building up opposition lines, which, upon the expiration of its contract with the Western Union Telegraph Co., would be used to crush the latter. For this reason, it is claimed that Jay Gould is anxious to sell out to the government. The whole makes a very plausible story, but it is very pertinently stated that there is nothing to prevent the telegraph company from engaging in the telephone business also, so it seems very probable that both companies will see the wisdom of continuing their amicable relations.

The setting aside of Judge Andrews's injunction against the city authorities preventing their interference with the wires of the electric light companies, was the signal for a general onslaught upon existing lines that has been of incalculable damage to vested interests. By the stopping of dynamos and proper procedure the work could have been done in a much more effective, if less sensational manner. As it is, about $100,000 worth of new wire has been practically ruined, and the business of the companies virtually suspended. Even the newspapers appear to be tired of the theme, and the era of darkness is teaching them to look fondly upon the gas interests, which for years have given them material for paragraphs, when the mother-in-law and ice cream had become wearisome.

The well-known electrical supply house of J. H. Bunnell & Co. has moved into an apparently desirable location at the corner of Cortlandt and Washington streets. This was formerly out of the electrical trades district; but many engineering companies are now in that vicinity, while its proximity to the Pennsylvania Railroad station makes it particularly accessible for out-of-town visitors.

NEW YORK, December 27, 1889.

PHILADELPHIA.

Brick Machinery Run by Sprague Motors at the Master Builders' Exchange.—Ordinances Touching Telegraph and Electric Light Wires.—A New Letter-Stamping Machine.—Poor Gas Light in Philadelphia Giving Way to Electricity.—A Large Business House Will Use Electric Light Throughout.—Mr. Ralph W. Pope's Lecture at the Franklin Institute.—The Electric Power Co. of Philadelphia, Chartered.—Williamsport's Electric Light Plant Now in Operation.

AT the Master Builders' Exchange, Nos. 18–24 S. 7th street, this city, there is a very interesting exhibit made by the Chambers Bros. Co., brick machinery manufacturers, of this city. By courtesy of the exhibition department of the exchange they were offered space in which to exhibit during the Brickmakers' Convention here a working model of the well-known "Chambers" brick machine, and joining forces with the Sprague electric motor people, have their machine making daily large numbers of miniature bricks by electric power.

The electrical committee of councils received from a sub-committee of its members a few days ago, a favorable report on the ordinance giving the Western Union Telegraph Co. permission to lay its wires in the conduits of the Bell Telephone Co. Councilman E. W. Patton declared that the bill was faulty, and opposed it. After some discussion it was decided to report the ordinance favorably to councils.

Negative reports were ordered upon an ordinance giving the Southwestern Electric Light Co. permission to erect poles and string wires.

A new letter-stamping machine has been put on trial in the Philadelphia post-office. It is run by electricity, will cancel about 25,000 letters an hour, and has a register that keeps count of each letter stamped. This may do away with the services of a few stampers.

"Why has the Bureau of Gas been compelled to resort to electric lights?" was asked of Director Wagner. "Ask the farmer why he sends his best produce to market and consumes the inferior stuff in his household," was the general's reply. But the general is "away off" in this matter. For some time past the gas in this city has been of the worst imaginable kind, and numerous storekeepers who use large quantities of gas in their business, threaten to substitute electricity if the quality is not improved. This is about what it will come to, eventually any how.

Owing to the increase of their retail business, Sharpless Brothers have decided to remove their wholesale department from 8th and Chestnut streets to the large building formerly occupied by Young, Smyth, Field & Co., at Nos. 812 and 814 Market street, and the entire structure, five stories high and 40 by 281 feet, will be lighted throughout with electricity.

Mr. Ralph W. Pope, of New York, secretary of the American Institute of Electrical Engineers, delivered a lecture at the Franklin Institute in this city on the evening of December 16, on "Electricity—Its Past, Present and Future." The lecture room was crowded with an attentive and appreciative audience. Mr. Pope handled his subject in a masterly manner, and was frequently interrupted by applause during the hour and a half which he occupied in its delivery. At its close, Mr. Pope was heartily congratulated, and quite a number of people detained him on the platform, plying him with questions upon points in his lecture. These inquisitive people were quickly satisfied and left the room with an enlightened and broader view as to the uses and power of electricity.

A charter has been granted at Harrisburg, to the Electric Power Co. of Philadelphia, capital, $150,000.

Williamsport's new electric light plant is now in full operation.

PHILADELPHIA, December 18, 1889.

BOSTON.

The Great Fires at Lynn and Boston; Newspaper Investigations and Official Investigations; Private and Official Opinions and Recommendations.—Electrical Displays at the Maritime Exhibition.—Electrical Trade Notes.

THE two great fires in our vicinity recently, that at Lynn November 26, and at Boston November 28, with the electrical questions which have been raised, since then, have been absorbing topics among citizens and especially those interested in electrical matters.

The fire at Lynn, was caused by the heat of a kerosene lamp in the vicinity of oily leather in an inflammable structure. A meeting of the citizens with the mayor and aldermen was held on December 1. As the result of the meeting, a petition, which includes the following, will be circulated for signatures :—

> That the city council shall prohibit, in this fire district any telephone wires or any electric light wires unless the same are placed underground; that the telephone central office be removed to a location outside of this fire district, thereby taking a thousand wires out of Central square and the streets in its immediate vicinity; and that the city council locate a special street to run the telephone poles and wires upon on the northern side of Buffum and Cambridge streets, and south of Market street, across Pleasant street.

Concerning the big Boston fire of Thanksgiving Day, the daily press, as usual, are extremely busy investigating the cause. At first it was quickly settled by them, that the falling of an electric time wire across the trolley wire of the West End Street Ry. Co. was the immediate cause of the disaster; but that hypothesis was quickly set aside when Mr. Pearson, the electrician of the road, informed the investigators, that there had been no current in the portion of the trolley wire when the cross was found. The cause was then explained by the crossing of the time wire with an electric light wire, which seems probable, though not proven. It appears that the clocks on the time circuit from the alleged cross to the seat of the fire were found to have been either burned out or stopped just before the fire was discovered; and as the Brown, Durell & Co. building contained the central station of the American Electric Time Co., this building being the starting place of the fire, color is given to the charge that electricity was the cause of the destruction of $5,000,000 worth of property.

The fire commissioners are still investigating the circumstances, about 150 pages of evidence having already been taken, and there will probably be as much more, taking up perhaps another month.

A conference held on the evening of December 1, at Mayor Hart's house, was attended by Professor Thomson of the Thomson-Houston Electric Co., Joseph W. Larish of the Western Union Telegraph Co, Captain Griffin and President Whitney of the West End Street Railway, Mr. Denver of the New England Telephone Co., President Gilbert and ex-Mayor O'Brien of the Boston Electric Light Co., Captain Flanders of the city's fire alarm department, and Corporation Counsel Richardson. The conference agreed that the increase in electric wires is a constant source of danger, as the highly charged wires are constantly liable to come in contact with ordinary telegraph and telephone wires and thus to carry destruction into any building that has a telephone or is otherwise connected with a network of wires that covers the city. It was agreed that an effectual control of all these wires by a competent officer is imperatively needed, being alike in the interest of the companies and the public. It was agreed also that the city can control all wires by a properly drawn ordinance. Some of the gentlemen expressed great faith in the safety fuse used by many electric companies.

Mayor Hart in addressing the board of aldermen, used the following words:—

"The Bedford street fire of November 28, which destroyed precious lives and millions in property, is suspected to be the direct result of a low-power wire coming in contact with a highly charged wire. Should this suspicion prove unfounded, the fact still remains that ordinary telephone and telegraph wires are an immediate source of danger the moment they touch an electric light or power wire, such as may be found in all parts of the city and are daily increasing. This crossing of wires is the greatest danger with which we have to contend. Putting the wires underground is apt to increase the danger, because it brings all sorts of wires into close proximity. The true remedy is known to electricians and fire insurance companies, and consists in a safety fuse of fusible alloy, inserted in every telephone or any other electric wire just before it enters a building. The cost of this contrivance is trivial, and the protection it affords is almost absolute, in that it breaks the continuity of conductors when these become heated to the danger point. A great, constant and increasing danger can thus be averted provided your honorable body will pass an ordinance with a penalty attached, for every case of disobedience, requiring every telephone, telegraph and other electric wire, that enters any building in Boston, to be provided with a safety fuse or fusible alloy, satisfactory to the fire commissioners or to the superintendent of the fire alarm."

In closing, the mayor said:—

"I renew my recommendations of October 21, and I may add that, while our city has full power to protect itself and the people of Boston from all danger occasioned by electric wires, this power has not been exercised by adequate ordinances and through a qualified officer."

This plea for the protection of the city and its inhabitants was followed by a few words from the fire commissioners, before the same body. After asking for an appropriation large enough to replace the apparatus lost by the falling of buildings, the commissioners said:—

"With the bare trolley wire threading our narrow streets, there will be a constant and all-pervading menace of a repetition of such conflagrations as that through which we have just passed, and the city will be fortunate if the fires caused thereby are confined to one building or one section at a time. Moreover the overhead feed wire cable stretched over poles in some streets must form a source of delay and trouble in preventing the speedy use of ladders. The electrical question is one which affects the fire department more than any other public interest. If measures can be devised to lessen these dangers to life and property, it will confer a great benefit upon this department, and, the commissioners believe, upon the public generally."

The fire has more or less hastened the stringing of guard wires over the trolley wire of the West End Road. As a measure of protection this is rather effective, there being three guard wires running above and parallel to the trolley wire, thus keeping flying wires from making a contact with the same.

An excellent opportunity to examine electrical machinery and the applications of electricity to lighting and power uses, is offered at the Maritime Exhibition, now being held here. The installations are numerous, and reflect credit upon the exhibitors. Walking down the main aisle the sight is everywhere impressed by the electric lights, arc and incandescent, in great profusion. Nearing the centre of the hall one hears the rumble of cogs, and glancing in that direction he sees the Thomson-Houston Electric Co.'s exhibit, surrounded by a halo of many colored incandescent lamps. This exhibit consists of their electric hoisting machine or "donkey." It is designed to work on an incandescent circuit, and has a capacity of 10 h. p. It will lift a half-ton tub of coal or 1,200 pounds at a speed of about 200 feet per minute. The machine is handled entirely by three levers and is under perfect control by the operator. It is fitted with all the latest devices for motor work, carbon brushes, laminated gear wheels, self-oiling bearings, etc. The complete installation of this company, comprises 10 machines, a 10,000 c. p. search light and 350 incandescent lamps.

A 400-light incandescent dynamo is run by an Armington and Sims engine and link leather belting. The search light is similar to those in use upon the naval vessels, it is run by a dynamo in the basement which receives its power from a Westinghouse automatic engine by means of the Evans friction cone. This system is invaluable aboard ship, where room is so valuable since it dispenses with belting altogether. Two 15 h. p. generators driven by the main engine furnish power for the various motors in use about the building. About 25 h. p. in a number of T-H. motors run silk looms, printing press, pump, fan blowers, etc. The Lamson Store Service Co. have a variety of cash railways run by a ½-h. p. Eddy motor, and Cabot and Holtzer have a 5 h. p, Eddy motor on exhibition, besides an interesting exhibit of primary and secondary batteries, and other electrical furnishings. The "C. & C." Electric Motor Co. have a number of small motors running various machines, lathes, etc.

The annual meeting of the Boston Electric Club, was held on Thursday evening, December 12, in the club room No. 7 Park street. The business transacted was the election of officers for 1890; the balloting resulted as follows:—President, Henry B. Cram; first vice-president, A. L. Rohrer; second vice-president, Geo. B. Neal; third vice-president, G. W. Adams; fourth vice-president, C. W. Holtzer; secretary, R. F. Ross; treasurer, F. J. Boynton; historian, G. W. Mansfield. A board of 20 directors was also elected, the president and four vice-presidents being added by a vote. It was voted to hold the banquet on January 6, 1890, at which time the officers will be installed and the reports of the year read.

The Edison Electric Illuminating Co. have issued a small catalogue of electric power users, employing their current as a motive power. An examination of its pages discloses the fact that there are 226 firms in this city, representing 32 industries, using electricity from the Edison circuits for power purposes. This company has also published a card setting forth the prices at which they will furnish power to consumers. This is undoubtedly an excellent idea, for the public know but very little about the cost of electric power. As stated in their handbook "the electric motor is the safest, quietest, cleanest, simplest, most reliable, handiest and most economical prime mover in existence. The Edison company here have recently started, or have about ready to start, 1,300 lights in Boston; two 500-light dynamos in Marlboro, Mass.; 900 lights at Manchester, N. H.; 900 lights in Augusta, Me. Total, 4,100 lights.

The eastern office of "C. & C." Electric Motor Co. have within the last few months installed the following:—18 ⅛-h. p. motors, 6 ¼-h. p. motors, 4 ½-h. p. motors, 2 1-h. p. motors, 4 2-h. p. motors, 2 3-h. p. motors, 2 4-h. p. motors, 2 10-h. p. motors, 90 fan outfits; an aggregate of 40 power motors and 90 fan outfits.

The Standard Electric Co., of Vermont, have the following installations:—

Boston, Hyde Park, E. Walpole, Orange, Newburyport, Spencer and Beverly; in Massachusetts, 2,450 lights; Whitefield and Milton, N. H., 400 lights. Benton and Springvale, Me., 1,200 lights; Clinton, N. J., 500 lights; Lyndenville, Vt., 125 lights; Central Falls, R. I., 1,300 lights, a total of 5,975 lights.

The Mather Electric Co. have put in about 9,000 lamps in Fitchburg, Lowell, Nashua, Hartford and Boston. And still the good work goes on.

The Boston theatre is the fifth playhouse in the city to be fitted with electric lights. There will be no lack of appreciation of the change from gas, alike from those who have felt the discomfort of heat in the spaces under each gallery and from those who have sat in either of the upper galleries and have had to face the great chandelier.

BOSTON, December 18, 1889.

.... As Americans it does not behoove us to ask the authorities to pass laws which will limit our work to that particular system that we have partially developed.—*George Cutter.*

CHICAGO.

The Electric Club; Mr. F. G. Beach, the New President, Takes the Chair.—Reconsideration of the Resolutions on Mr. Edison's North American Review Article.—A Paper on Arc Lighting in Chicago by Mr. C. E. Gregory.—Resolutions on the Death of Mr. E. S. King.—Mayor Hart, of Boston, Examines Chicago's Electric Lighting Methods.—His Approval of its Underground Work.—A Chicago View of the Electric Light Situation in New York.—Electrical Subscriptions to Chicago's World's Fair Stock.—The Northwestern Association of the Massachusetts Institute of Technology Graduates.—Alleged Use of the Telephone by the Cronin Conspirators.—A Novel Use of Incandescent Lamps.—Work of the Electric Light Association Committee on the Copper Duty.—Success of Electric Lighting in the Auditorium.—"Drop a Dime in the Slot."—The New Offices of the Edison and the Sprague Companies.

AT the meeting of the Chicago Electric Club, December 2d, President Beach occupied the chair for the first time. In calling the meeting to order he thanked the club for selecting him as its presiding officer, and suggested that steps be taken for the formation of a club library. The resolutions adopted at a previous meeting, which expressed the members' disapproval of Mr. Edison's article on the "Dangers of Electric Lighting" in the *North American Review* were reconsidered. This action was taken at the suggestion of Mr. Sunny, who had drafted the resolutions. He said his opinion regarding Mr. Edison's article was unchanged, but he deemed it unwise for the club to take action on it, for the reason that it might involve the club in a controversy on a trade matter. He thought purely business affairs should not engage the attention of the club. He continued to believe, however, that Mr. Edison's article was unjust and incorrect. Mr. Sunny's views were accepted by the club and the vote for a reconsideration of the resolutions was unanimous. The treasurer, Mr. F. S. Terry, presented his report, showing that the club was in a flourishing financial condition.

At the meeting of December 16th, Charles E. Gregory, of the Sperry Electric Co., presented a paper, in which he traced the development of arc lighting in Chicago. There were at the present time, he said, about 6,000 arc lights in operation in Chicago. He predicted that in 1892 there would be at least 10,000 arc lights illuminating the city.

At this meeting the club adopted a series of resolutions in memory of E. S. King, of Jacksonville, Ill., an honorary member, who died recently.

Mayor Hart, of Boston, was in Chicago a short time ago, and devoted considerable time to the examination of the local electric light systems. He has been traveling about the country to post himself on electric lighting generally, but particularly to gain information which may aid him in dealing with overhead wires in Boston. He thought the overhead construction in Boston was extremely bad. A heavy storm, he said, would tangle the circuits in fearful confusion. It is a noticeable fact that on his return to Boston Mayor Hart said, in reply to the questions of an interviewer, that Chicago had done more real honest work in the way of putting wires underground than any city in the country. He thought that Chicago's system might serve as a model for Boston.

"I am not a believer in faulty electric light circuits," said a gentleman a few evenings ago to a party of friends who were discussing the recent fatalities from electric light wires in New York city, "but I'd run my chances rather than to have darkness in the city. Light at night is the friend and protector of an honest man, and one needs it badly in New York city. I don't think there is any need of bad circuits, but I am simply speaking of a choice between two evils, and we often have such alternatives to select from in this world, unfortunately. I have been impressed with the fact that the New York companies which have allowed their systems to become so dangerous have a great deal to answer for. They have hurt the business greatly throughout the country. Why, my wife wants me to get out of the business, she is so impressed with the dangers which the newspapers have pointed out. I am a believer in both the high and low tension systems. I am not prejudiced against direct or alternating currents, so I do not speak with the idea of depreciating any system. I want work well done and safely done; that is all. I find that persons want all sorts of guarantees made when a plant is installed, which were not thought of before these fatalities in New York. I would like to bring suit against the New York companies to obtain money enough to cover the sums I would have made had not people been too scared by the New York accidents to buy plants. When a man tells me that he is afraid to install a plant now, I, of course, tell him my system is perfectly safe, but he always says, 'Oh, pshaw! don't say that; don't try to fool me; all you electric light people say that.' The New York accidents constitute a mighty argument for good construction. I hope it will be heeded. It is no use talking to people about the deaths from steam cars, or gas, or boiler explosions, or cable cars, or elevators. There may be many more accidents than from electric light wires, but the fact doesn't remove the fear which people have begun to entertain for wires. People simply say you can guard against other dangers, but not against those from the wires."

B. E. Sunny, chairman of the committee appointed by Mayor Cregier to represent electrical interests on the Chicago World's Fair committee, has reported the following stock subscriptions with the accompanying two per cent. payment:—Western Electric Co., 250 shares, clerks, 98; F. W. Horne, 15; S. W. Trawick, 5; Brush Electric Co.'s employés, 55; Thomson-Houston Electric Co., 250, employés, 150; Chicago Arc Light and Power Co., 100, employés, 150; W. A. Kriedler, 10; F. DeLand, 10; Central Electric Co.'s employés, 122; Foree Bain and employés, 22; Electrical Supply Co., 25, employés, 15; Knapp Electrical Works, 25; T. P. Bailey, 15; C. & C. Motor Co., 15; Chicago Edison Co.'s employés, 96; Sperry Electric Co. employés, 53. In addition to these the workmen employed by the Western Electric Co. have subscribed for 300 shares, making a total of 1,781 subscribed by the electrical fraternity of Chicago.

The Northwestern Association, of the Massachusetts Institute of Technology, held its third annual meeting in Chicago, December 7th. Among the guests of the evening was Professor Charles R. Cross, who has charge of the department of electrical engineering in the institute. Louis A. Ferguson, of the Chicago Edison Co., read a paper on "Applications of Electricity."

In his summing up speech for the defense in the Cronin case, one of the attorneys thus spoke of the charge that two of the conspirators had been heard communicating by telephone:—"The telephone is a very useful invention, but I will venture to state without fear of successful refutation that that instrument was never yet made use of by criminals, because it is a public thing. Anybody can hear that has any sort of communication with the wire at either end, and more than all that, it is improbable and unnatural that men should employ the telphone for the purpose of communicating any secret."

The managers of the Westinghouse station at Englewood, which is now a district of Chicago, made a novel installation a few evenings ago. At a bazaar, several young ladies gave a drill in military dress. They wore helmets in which were placed red, white and blue incandescent lights. In certain parts of the drill the lamps were illuminated and the effect was very striking. The operation was very simple. A converter was placed on the outside of the building. The secondary wires ran under the stage and were connected to a number of brass plates on the floor. The young ladies were properly wired from the lamps on their helmets to the heels of their shoes, on which were fastened small brass plates. When they stood on two of the plates on the stage the circuit was complete and the lamps flashed up brilliantly.

C. A. Brown, chairman of the committee of the National Electric Light Association, which was appointed to memorialize Congress to remove the copper tariff, has prepared the petition and states that the committee is prepared for aggressive work. He says that the interest which has been shown in the object of the committee is highly encouraging.

The opera season is now in progress, and the magnificent auditorium is splendidly illuminated. The arrangement of lights was studied with great care and their decorative effect is almost as important and striking as their illuminating power. Many new electrical devices are used on the stage to add to scenic effect.

S. M. Dowst and Frank H. Hosmer have invented an ingenious little appliance for a telephone, the principle of which is that the insertion of a dime in a slot is a condition precedent to the use of the instrument.

The Edison and Sprague companies have moved into new offices in Chicago in the Rialto buildings. They are the finest offices occupied by electrical companies in the city. The floor space is 6,000 square feet, one-fourth of that on the main floor of the building.

CHICAGO, December 23, 1889.

ST. LOUIS.

The Consolidation of Lighting Interests in St. Louis.—The Municipal Electric Light and Power Co. and its City Contract.—A Temporary Electric Installation by the Laclede Gas Light Co.—The Westinghouse Station of the Missouri Electric Light and Power Co.; It Will be Ready for Service January 1st.—Official Investigation of the Electric Light Combination.—The Short Series Electric Railway.—The Thomson-Houston Railways.—The Fort Wayne Plant at East St. Louis.—Electric Railway Notes.—The Southwestern Electrical Engineering Co.

THE Municipal Light and Power Co. has passed into the control of the Hollins & Co. syndicate of New York. The deal was effected by James Campbell, broker, of this city, by purchase from Seligman & Co. and Ladenburg, Thalman & Co., of New York. As the Hollins & Co. syndicate control the Laclede Gas Light Co. and the United Electric Light and Power Co., it naturally follows that the Laclede Gas company will control the Municipal Electric Light and Power Co. The result of this will probably be a combine, if not an actual consolidation of the United

Electric Light and Power Co., the Municipal Electric Light and Power Co. and the St. Louis Illuminating Co. This will place the Laclede Gas company in absolute control of all electric light companies in the city, except the Missouri Electric Light and Power Co. (Westinghouse system). The St. Louis Illuminating Co. (of which James Campbell is president) will hold an election December 31st, the object of which is to increase their capital stock from $100,000 to $500,000. The object of this increase of capital stock is not made public, but it undoubtedly has some connection with the combination. At an election yesterday James Campbell and John P. Kelly, of St. Louis, and Elish Dyer, of New York, were elected directors of the Municipal Electric Light and Power Co.

The Municipal Electric Light and Power Co. finding that they can not finish their plant in time to light the city after January 1st, 1890, have asked the city legislature for ninety days extension of time. The matter was referred to the board of public improvements, who decided that no such extension could be granted. This leaves the Municipal Electric Light and Power Co. in a predicament. That is, they will have to pay the city a fine of $500 per day until they light the city with arc lights. The Municipal Electric Light and Power Co. will probably make some arrangements with the Laclede and St. Louis Gas Light Co.'s for continuing their gas lighting until they can finish their plant.

The Laclede Gas Light Co. finding it impossible to finish their electric light plant in time to begin lighting the north end of the city on January 1st, 1890, are installing a temporary plant at the old Western electric station of the United company, corner of Second and Franklin avenue. The instalment consists of two Heisler alternators of 450 30-c. p. capacity for lighting the alleys, and one Brush alternator of 600 16-c. p. capacity for lighting the city buildings.

The Missouri Electric Light and Power Co. are putting in two batteries of Babcock and Wilcox boilers of 500 h. p. each, and two 3,000 light Westinghouse alternating dynamos. This company has nearly everything in readiness to begin their incandescent lighting in the south end of the city, and will be able to fulfill their contract promptly on January 1st, 1890.

On account of the supposed electric light and gas combine, the House of Delegates at their last meeting passed a resolution for the appointment of a special committee to investigate as to whether or not the gas and electric light companies have formed a combination for the purpose of putting up the price of gas and electric light and power.

The St. Louis Board of Fire Underwriters notify the public that on account of numerous accidents and increased number of fires, caused by improper wiring, the board have instituted an inspection of wiring and fittings of buildings. The board will issue certificates, free of charge, for all work done according to their rules, and request all parties entering into contracts for wiring to notify the board of such work before the work has progressed.

The Short Series Electric Railway has been delayed in completion, but it is expected to begin operation next week. Mr. Short and his associate, Mr. Adams, are here attending personally to the final details of fitting up.

The Union Depot Street Railway Co. have finished laying rails on their new division from the corner of Gravois avenue on California avenue to Gyer avenue and Jefferson avenue. This division is to be operated by the Thomson-Houston overhead system.

The St. Louis and East St. Louis Electric Railway (Thomson-Houston system) is now in successful operation. The management are planning for an extension of their line to the National Stock Yards, and will duplicate their power plant at once. The city of East St. Louis has granted them a franchise authorizing this extension.

The Citizens' Electric Light and Power Co., of East St. Louis, organized last October, are installing 120 Wood arc lights and 500 Slatterly incandescent. The work of installation is being done by the Fort Wayne Electric Light Co.

D. B. Alexander, principal owner of the Belleville street railway, has been granted the privilege of changing to electric power. He has also asked for a franchise in East St. Louis, and intends to extend his electric railway from Belleville to East St. Louis, making connection with the St. Louis and East St. Louis Electric Railway. Topeka, Kan., parties are interested in the enterprise.

The Electric Railway Light and Power Co., of Topeka, Kan., have been granted a franchise by the city council of Sedalia, Mo., to build an electric railway some four miles in length, extending from the centre of the city to the water works. The work of installation is to be completed in twelve months.

The Southwestern Electric Engineering Co. were incorporated November 25th, with a capital stock of $10,000. C. J. Briner, A. Irvine and C. R. Meston, shareholders. They represent the Brush Electric Co., and are doing a large amount of wiring for them.

St. Louis, Mo., December 20, 1889.

.... It is not given even to a Newton to create an absolutely new light.—*S. P. Langley.*

PITTSBURGH.

The Pittsburgh and Manchester Railroad Co. to Abandon Horses.—A New Bridge from Pittsburgh to Allegheny.—The Allegheny Electric Light Plant.—The Pittsburgh, Allegheny and Manchester Electric Street Railway Co. Chartered.—The Sprague System to be Used on the Pleasant Valley Line.—Other Street Railway Notes.—The Star Iron Tower Co., of Fort Wayne, to Supply the Towers for Allegheny.—A New Arc Light System by the Westinghouse Company.—An Electric Club in Pittsburgh.—Further Electric Railway Notes.

The Pittsburgh and Manchester Railroad Co. has at last decided upon changing the present motive power of its road, viz., horses —and transform the road into a cable or an electric road. As has been previously stated in this correspondence, the company had to combat numerous difficulties and obstructions to this change. The chief obstacle was the Suspension Bridge, an old structure which spans the Allegheny river from Sixth street, Pittsburgh, to Federal street, Allegheny. A few days ago, however, the directors of the street car company met the directors of the Bridge company for the purpose of discussing propositions, looking to a practicable plan of operation for permitting the Pittsburgh and Manchester Railroad either to lay a cable or electric wires across the bridge. The meeting was fortunately successful, and the result is that an entirely new structure is to be erected in place of the old Suspension Bridge. The new bridge is to be so built as to accommodate either a cable or an electric road. The bridge is to have a double track for cars, a double track for ordinary vehicles and on each side a foot walk. About $160,000 are to be expended in construction, and it is predicted that the new bridge will be one of the finest structures of its kind in the country.

The Allegheny electric light plant is to be hastened towards completion, and it is expected to be in operation by next June. The plant is to have a capacity of 3,000 lights, Westinghouse alternating current system. Ground was broken for the power-house a few days ago on Braddock street, Allegheny City.

A charter was granted a few days ago to the Pittsburgh, Allegheny and Manchester Electric Street Railway Co., the incorporators being John H. Dalzell, A. M. Neeper, G. A. Hill, John D. Nicholson and W. T. Mustin. Inquiries made as to what the object of this charter were, brought out the information that the Pittsburgh and Manchester Railroad Co., which operates a regular net of street car lines between Pittsburgh and Allegheny, will adopt a system of electricity on the Rebecca street line, which is a branch of the main line.

Work on the Pleasant Valley street car line is now rapidly progressing and the directors of the company promise the citizens now that the electric cars will be running by the first of January. This is the company which is about to adopt the Sprague system of overhead wires. Twenty-five cars are expected to arrive here by the first of the year.

A new feature in connection with the working of this road is that the motor men and conductors have contracted with the company for a work-day of nine hours. The rate of wages will be on a basis of 20 cents per hour; any extra time called for in case of emergency to be paid for at the same rate. It is said that the company will call upon the men to work longer hours on Sunday.

The stockholders of the East End Passenger Railway held a meeting a few days ago in the Chamber of Commerce, and the sale of the property, franchises, etc., of the company to Mr. T. A. Gillespie was formally effected. Mr. Gillespie is the treasurer of the Central Traction road of this city, which runs from the lower part of Pittsburgh to the East End, and it is thought, that inasmuch as the East End Passenger Railway Co. owns the franchises for a road to Wilkinsburg, the Central Traction Co. bought them to extend its own line. Electricity is to be used on the new road, which is expected to be finished within a year.

The contract for furnishing the electric towers for Allegheny was closed last week between the Westinghouse Electric Co. and the Star Iron Tower Co., of Fort Wayne, Ind. The contract calls for the completion of all the material within 90 days.

The Westinghouse Electric Co. has just completed an entirely new arc light system, which is claimed to embrace many improvements and advantages. The dynamo is reported to be thoroughly self-regulating, maintaining constant current under any changes of load from one lamp to its full capacity. The dynamo is not only automatic in its regulation, but it is said to exhibit a distinct gain in efficiency over the results hitherto attained in commercial dynamos.

In addition to the dynamo, however, the system has also an entirely new arc lamp, for which similar gain in efficiency is claimed. A principal point among its features is an economy in carbons, which are claimed to last two or three times as long as they do in the present general practice. The mechanism of the lamp is simplicity itself, and its regulation is automatic in every particular.

A social organization is about to be called into existence in Pittsburgh, which will have for one of its chief objects the furthering of the interests of the electrical fraternity and the study of the comforts of the traveling electrician. The club is being established in the Westinghouse building in this city, the gigantic nine-story structure in which the offices of the various Westinghouse interests are situated. When this building was erected the ninth floor was at once arranged so as to make it suitable for the demands of commodious club quarters. The suite of apartments contains a very comfortable kitchen, pantries, closets, etc., a large room for a library, a barber shop, a billiard hall, two dining-rooms, a reception room, a couple of bed-rooms and offices as well as bath-rooms.

The main object of the club will be to afford the officials and clerks, of which there are about 200 employed in the building, a place where they may meet socially and where an opportunity will be afforded them to congregate daily for luncheon. An efficient steward will be engaged to look after the culinary requirements of the club members. Once a month it is proposed to have the members assemble during the evening for the entertainment afforded by scientific discussions or lectures. It is also intended to be the head-quarters of traveling salesmen of electric companies, who will be invited to partake of the hospitality of the club while in the city.

The organization will be duly incorporated and a charter has already been applied for. The chief promoters of the club, as far as has been learned, are Mr. Chas. Payne, the vice-president and general manager of the Philadelphia company; Mr. John Caldwell, the treasurer of the Westinghouse Electric Co.; Mr. H. M. Byllesby, the vice-president of the Westinghouse Electric Co.; Mr. Chas. S. Pease, the general superintendent of the same company; Mr. A. T. Rowand, the secretary; Mr. W. L. McCullough, the auditor; Mr. R. D. McGunnigle, the secretary of the Allegheny County Light Co.; Mr. G. H. Blaxter, the general manager of the Allegheny County Light Co., and several other gentlemen prominently connected with the many Westinghouse interests. It is expected that about $10,000 will be spent to fit up the club, and Mr. George Westinghouse, Jr., will be a liberal patron of the club.

A quiet little row has been in progress in this city for some time between the Squirrel Hill Electric Railway Co. and the city authorities, over the right of way given the company to pass over a portion of Schenley Park, by Francis Torrens, the agent of the Schenley estate, before the park had been presented to the city by Mrs. Schenley. Several meetings have already been held to settle the trouble amicably, but so far all efforts have been unsuccessful.

The rapid transit fever, which has now been raging in this city for over a year, resulting in the transformation of all street car travel, has broken out again on the south side of Pittsburgh. It is contemplated there by a number of prominent capitalists to build an electric road from Mount Washington to West Liberty, a distance of several miles. It is expected that the road will cost about $400,000.

The Second avenue electric road—Thomson-Houston system—is to be running by the first of the year.

PITTSBURGH, December 19, 1889.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE LAW OF INVERSE SQUARE.

[112.]—In the November number of the ELECTRICAL ENGINEER is an article on "The Law of Inverse Square."

The author attempts to prove that all central forces must vary inversely as the square of the distance, and bases his proof on the *assumption* (which he fails to mention in his summary) that

$$\frac{dX}{dx} + \frac{dY}{dy} + \frac{dZ}{dz} = 0$$

is simply the analytical statement of the fact that there are no centres of force" where this equation holds.

This is purely begging the question. Laplace first proved this theorem by *assuming* the law of inverse squares; and neither Green, Gauss, Maxwell, Thomson and Tait, nor any other writer that I know of, has proved this theorem without this assumption. It will not do to prove the theorem by the law and then prove the law by the theorem.

The author writes, with regard to Maxwell's experiment on the law of electrical forces:—"It is assumed that the force has a potential, from which it follows that in the space around the conductor the equation of Laplace holds true." This is clearly an error. Forces which vary as *any* function of the distance have a potential (Maxwell, Elect. and Magn. §70); but only forces varying as the *inverse square* of the distance satisfy Laplace's equation, as any one can readily verify for himself. Maxwell's experiment proves what he intended it to:—viz., the law of inverse squares for electrical forces. HARRY FIELDING REID.

CASE SCHOOL OF APPLIED SCIENCE,
PHYSICAL LABORATORY, Cleveland, O., Dec. 4th, 1889.

BADT'S INCANDESCENT WIRING HAND-BOOK.

[113.]—In the December issue of the ELECTRICAL ENGINEER, I notice a review of my little "Incandescent Wiring Hand-book." In his reference to the book the writer of the review states that I have made a serious mistake in developing formula vi., and shows how simple is the formula which he thinks should be substituted. To my mind this criticism indicates that the critic is not a *practical* electrician. In the first place, my formula is not more complicated than his if you eliminate the constant and simply write the formula as on page 62:—

$$d^2 = N \times D \times K.$$

It seems to me perfectly clear that a wireman will not make a calculation for more than one kind of lamp in planning work for a single plant; therefore he will calculate the constant first and apply for all his subsequent calculations simply the formula mentioned above.

But in the second place, even if it be admitted that the formula which I employ is more complicated than that proposed in your paper, I would still object to the use of the latter.

Almost every contract for electric lighting states *in percentage* the permissible loss in conductors and this method of statement has come into such general use that it must be recognized. Any table, therefore, expressing the loss must give it in *percentage* and not in *volts*. For a great many reasons this plan is very desirable, but I will mention a single illustration only. Suppose, for example, two companies bid on a plant, one on the 110 volt system, the other on a 75 volt system. If they both state that they will wire the building for five volts loss, it is evident that they are making entirely different proposals. If, on the other hand, each would state in its proposal that the total percentage of loss in the wires would be five per cent. of the total energy, the statements would be clear and fair in comparing the two cases.

I will further say that my formula, whose absurdity is so apparent to the gentleman who wrote the criticism in your valuable paper, is used by the engineering department of one of the three largest companies installing incandescent plants, and, therefore, is familiar to a great number of wiremen.

I may also be pardoned if I add that not a line in my little hand-book was published without having been subjected to the most severe criticism, not of office electricians only, but of practical incandescent wiremen. Whenever any one of these gentlemen whom I consulted found fault with what I had written or said, I took particular pains to review the statement and put my ideas in such language as seemed perfectly clear. I have tried to satisfy in this little book not office electricians who handle algebraic formulæ as easily as a boy his toy, but practical incandescent wiremen whom I hoped to educate to a higher standard. I think the criticism on these points is without foundation. I have changed quite a number of points in the second edition now printing in accordance with suggestions which I have received from a large number of gentlemen in the United States and abroad, but I did not see fit to change any data according to the suggestion of the gentleman who wrote the review referred to above.

There is one word which I may say concerning my assumption that the resistance of a mil-foot of copper wire was 10.79 ohms. The only error I committed in this respect was that I spoke of "pure copper." I should have said "commercial copper." We do not handle pure copper wire, and for calculating the loss of energy in copper wires in practice, we ought to assume a higher resistance.

You would very much oblige me by giving this reply space in the next issue of your valuable paper. F. B. BADT.

A STROKE OF LIGHTNING.

[114.]—It is remarkable with what persistency lightning avoids well arranged rods. The 25 buildings on the 46 acres of Lafayette College, have never been struck although some of them are very tall and all of them are on high ground. Pardee Hall, the seat of the Scientific School, was destroyed by fire in June, 1879, leaving a ragged mass of ruins. During the first storm after the fire these ruins received a terrific stroke, the lightning seeking the earth through a broken water conductor. Since rebuilding, there has been prefect immunity. On the same plateau with this building is a large community, with houses not so generally protected. The lightning frequently strikes here; also at the base of this elevated level where the main body of the town lies—150 feet below—lightning strokes are not infrequent.

This summer, a case occurred which seems worthy of record. No. 305 Monroe street, is one of a group of five dwellings situated on College Hill. The group is isolated—having nothing on the north, for a distance of an eighth of a mile, perhaps, at which point a spur of Chestnut Hill rises suddenly to a height of 500 feet; on the east is a narrow street, on the opposite side of which are two small houses; on the south there is a clear view for two blocks, and on the west, 150 feet distant, a large house protected with a rod. In the immediate neighborhood there are several other protected houses. The house struck is the western half of a "double" building; this and the other dwellings being separated by alleys three and five feet wide. It is the middle one of the group of five. No one of the five is rodded. It is not the most conspicuous by any means, the adjacent corner house being higher and having projecting ornaments on the roof. It extends a few feet further north than the others. The back part of the house, where the damage was done, is lower than the front. The point of attack was the ridge adjacent to a brick chimney which was pouring out hot gases from a very hot stove at its base, in the kitchen. The chimney was not disturbed. The charge tore the slates from the roof, split a rafter and made an earth through the tin water conductor leading to a cistern near by. At a point where the vertical pipe enters the funnel shaped vessel, the tin was perforated, the burr pointing towards the earth. It is well known that hot gases are good conductors, but here the charge avoided the column and the comparatively high brick chimney and struck the roof at a place probably not a dozen inches from the point of contact between the chimney and brick work.

Those who have performed the experiment of placing various pointed, rounded, and hot objects—like a lighted candle—on the metal plates of an air pump connected to earth and one pole of an induction coil—the other pole being joined to a tin disc suspended above, have seen just such a phenomenon as that cited above.

Lafayette College, December 24, 1889. J. W. MORN.

MULTIPLE TELEPHONY.

[115.]—It may be of interest to your readers to learn something more of the late interference case between J. J. Carty, John A. Barrett and myself, for a system of multiplex telephony which was pending for over two years in the United States Patent Office, and which interference was only recently dissolved by the question of priority of invention being decided in my favor.

This system contemplates the duplexing of long-distance telephone lines so that two subscribers or a subscriber and a central office operator at one end of a trunk line may communicate with two subscribers, or a subscriber and a telephone operator at the other end without interference. This is accomplished by using a metallic circuit between the two central offices and by connecting a subscriber's line to each end of said metallic circuit. The trunk line operators are supplied with differentially wound transmitters and receivers. One coil of each transmitter and of each receiver is inserted in the outgoing wire of the metallic circuit and the other coils are inserted in the return wire. Each transmitter has a local circuit common to both induction coils and each of said induction coils is provided with an adjustable core for balancing the two branches of the metallic circuit.

By "connecting up" the receiver coil and the transmitter coil of one branch of the metallic circuit, with a pole charger, the trunk line instruments may be made to actuate and respond to either system at pleasure. That is, when the pole charger is turned in one direction, that trunk line instrument is in touch with the other trunk line instrument only, and when the pole charger is turned in the opposite direction, that instrument is in touch with the subscribers' instruments only. Hence the two systems are independent of each other, and may be used simultaneously and without interference. In one case the telephonic currents traverse the metallic circuit in the same direction, and in the other case the currents move in an opposite direction. In this way the working capacity of trunk lines may be doubled and the expense of operating said lines proportionately diminished.

Toronto, December 23d, 1889. A. M. ROSEBURGH.

RECENT PUBLICATIONS.

Electricity in Modern Life. By G. W. de Tunzelmann, B. Sc. London: *Walter Scott.* Crown 8vo., cloth, viii., 272 pp. Illustrated.

Practical Electrics. A Universal Handy-Book on Everyday Electrical Matters (Reproduction of the Chapter on Electrics in the Third Series of "Workshop Receipts." New York: *E. & F. N. Spon.* 8vo., cloth, 135 pp., 126 engravings. Price, 75 cents, post-paid.

Practical Electrical Notes and Definitions, for the Use of Engineering Students and Practical Men. By W. Perren Maycock. New York: *E. & F. N. Spon.* 32mo., cloth, 130 pp., with diagrams. Price, 60 cents.

Whipple's National Electrical Directory and Electric Report. 1889. Detroit: *F. H. Whipple.* 8vo., cloth, 592 pp.

.... THE best man to take charge of a system of distributing light and power is an experienced mechanical engineer who possesses a good working knowledge of the simple laws which govern electric distribution in wires.—*John Perry.*

NEWS AND NOTES.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

MEETING OF DECEMBER 17, 1889.

Professor Harris J. Ryan, of Cornell University, read a paper on "Transformers." (See page 7.)

DISCUSSION.

Mr. Townsend Wolcott—Did I understand Professor Ryan to say that the loss of energy is necessarily less where there is mechanical vibration?

Professor Ryan—It seemed to us to have been so in this transformer; but we are not sure of it.

Mr. Wolcott—On the supposition that it is so, where does the energy come from? The idea is that the reversal of polarity of the iron absorbs a certain amount of energy in any case; is it not?

Professor Ryan—The idea, I suggest, amounts to this: that the energy that was taken up in shocking that iron was less than what was saved in the hysteresis. That is, the hysteresis was made less by a greater amount than the energy that was spent in shocking the iron.

Mr. Wolcott—That is the way I understood it; but is there any explanation why that should be so?

Professor Ryan—Not that I know of. I have not thought of the matter to any great extent, or further than I have indicated.

Mr. Nikola Tesla—Professor Ryan has said that the form of the primary current wave departed considerably, in certain conditions, from that of the primary electromotive force; and he also stated to what he thought this departure due. I think that this departure of the primary current wave from that of the impressed electromotive force is due, to a considerable extent, to the conditions of the secondary circuit of the transformer, and I regret that Professor Ryan has not shown in the secondary an inductive resistance instead of the lamps. I think that then there would have been found a still greater departure of the primary current from the primary electromotive force. If we close the secondary circuit through a non-inductive resistance, such as lamps, it diminishes the lag of the primary. If we close it through an inductive resistance it increases the lag of the primary. In this way two effects may be produced; first, the primary current wave will depart more or less from that of the electromotive force; second, the secondary electromotive force will lag behind the primary electromotive force, as Professor Ryan has found.

Professor Ryan—I would like to ask Mr. Tesla how he would produce that inductive resistance in the secondary circuit?

Mr. Tesla—When you close the secondary circuit through the resistance suppose that you put a coil of wire in the circuit instead of the incandescent lamp.

Professor Ryan—Would you not be increasing the hysteresis effect in that way? It seems to me that then just what you say ought to follow? Of course it should be understood that stress is laid merely on the fact that there is a certain component at all times flowing to keep up the magnetism; but, aside from that, whatever current passes is merely the opposite of that which passes the secondary circuit.

Mr. Tesla—You stated that this departure was due only to the hysteresis.

Professor Ryan—Suppose that you use hysteresis in the secondary circuit, and thereby augment the irregularities of the primary circuit; is it not, after all, ultimately due to the hysteresis?

Mr. Tesla—But suppose instead of the incandescent lamp you use a coil of inductive resistance, which would take the same current as the lamp?

Professor Ryan—When you use any device by means of which you introduce hysteresis in a secondary circuit, do you not greatly augment the displacement of the primary current?

Mr Tesla—Of course as we load the secondary with lamps the primary comes closer and closer to where it ought to be; and I think if you had made a trial with an inductive coil in the secondary circuit instead of the lamps it would have shown some interesting conditions.

I believe Professor Ryan stated that the secondary electromotive force commenced at a given point to lag behind the primary electromotive force?

Professor Ryan—Of course it is gradual.

Mr. Tesla—Have you not noticed, for instance, when this takes place, that it began suddenly?

Professor Ryan—No; I have not noticed that it began suddenly.

Mr. Tesla—I should say that when the secondary circuit has a different retardation from that of the primary circuit, then this condition begins. That is to say, if you have a primary coil, and you pass the current through that coil, and you have the secondary circuit closed, you then observe a certain lag of primary current. Now, if you add in the secondary circuit an inductive resistance, you can cause a still greater retardation in the primary. And if you diminish the retardation of the secondary, by inserting lamps, you diminish the retardation of the primary circuit to a greater extent than that of the secondary; thus in both cases causing the secondary electromotive force to lag behind the primary.

Professor Ryan—I would like to say that Mr. Merritt and I intend to continue our work in this line, but, of course, we wish to vary the circuits upon which we experiment. As soon as we have done this work on the transformers we expect to take up the action of the condenser in all its relations to circuits possessing inductors, and to circuits not possessing inductors; and will test this matter which Mr. Tesla has just spoken of by working a coil in the secondary circuit, instead of a lamp. I think that a great deal is brought out in this way; and that one would be able, by careful study, to predict fairly well what would take place by varying the conditions.

Mr. A. E. Kennelly—There are two points about which I would like to ask Professor Ryan. One is with reference to that very distorted curve that we see upon the first sheet, representing the values of the electromotive force and currents when the secondary is open. I understood Professor Ryan to say that the square root of the mean square of the primary current corresponding to that distorted curve did check with the average of the square roots of the ordinates as compiled in the series. Now that statement, supposing it to be rigidly accurate, is tantamount to an assertion that the primary curve, which looks so distorted, has really the position of two sine curves; because, if I mistake not, the sine curve is the only curve which possesses the property that the square root of the mean square should represent that average. It would therefore mean this: that the primary current, starting under the impulse of that primary impressed electromotive force (which we will assume to be a true sine curve) shall meet with an opposing force, which is of itself a sine curve. I think it is important to know whether that is so or not. I think it would also be interesting to know how far the observations before us show whether the curve of the impressed electromotive force is of a true sine nature or not. We know that it approximates to it in a great number of cases; and we know also that in alternating current dynamos the curve is by no means of a true sine type. It is fundamental in the whole subject we are studying to know how far the deviation is from the theoretical sine curve.

The question of hysteresis is of very great importance in every point of view. We know that we can measure the amount of energy which a converter absorbs in a given time; and we can measure also the amount of energy that it delivers in a given time. We have then to deal with the remainder of energy absorbed by the converter uselessly; and this is to be found, first, in a purely frictional resistance to the current, whereby the energy is transformed into heat; and second, in the effect of the magnetism there is in the current producing the magnetic lag. It is of the very highest importance that we should be able to separate those two forces; and the paper before us gives very important suggestions by means of which we can carry that differentiation into effect. The Foucault currents can be reduced sufficiently by diminishing the cross-section at any one point; and we know that in good transformers such currents can be reduced to a minimum; but what we do not know is the quantity of energy which is being absorbed in the hysteresis under the conflicting conditions which are perpetually occurring.

In civil engineering we are brought face to face with the wonderful fact that a very large portion of its application and design lies in the general knowledge of the properties of the molecules of iron in the different conditions in which iron is used; and the mystery grows more and more when we remember that in electrical engineering it is not so much the mechanical properties of iron, in the mechanical engineering sense, as it is the electrical properties of iron, which concern us, and which vary perpetually in every design for apparatus; because, after a piece of apparatus has passed from the stage where the wonder is no longer new, then the question comes: How much can we economize and save out of a given mass of iron or copper? And the question, which is coincident with that, of how much we can save, or waste of hysteresis in iron becomes of greater and greater importance.

In hysteresis we have two distinct things to deal with; first, we have the fact that the iron will not return immediately to its previous condition after some magnetic effect has been impressed upon it; and, secondly, that it has a frictional resistance, and cannot instantly obey the reversed force. In all slow working transformers, in all pieces of apparatus where the changes are slow and steady, we can generally neglect what is called the frictional hysteresis due to speed, and simply deal with the static hysteresis; and it becomes of the very greatest importance that we should be able to distinguish between the statical hysteresis and the physical hysteresis. With regard to the question asked as to the effect of mechanical shocks on hysteresis, I think I may suggest a possibility, namely, that it is simply a question of how the magnetism which has been left after a given impulse can be shaken out; and if you can shake that magnetism out by any means you will have that hysteresis destroyed. If you will study the hysteresis chart before us you will see that the area of the curve represents actually the amount of energy which is being consumed or delivered from the cycle in the iron through its magnetic effect; and if you can prevent that taking place that lag would disappear.

I think the question of the differentiation of the physical hysteresis from the static hysteresis is one which has gone beyond experimental methods, and has become one of very great importance; and if words were necessary to recommend its importance still further, is it not enough to consider that apart from practical considerations it has also a very important scientific bearing; because, by the way in which magnetism acts upon iron (the most completely magnetic substance we find in nature) the more readily can we guess at the principles which underly the whole phenomenon of magnetism; and the more completely can we discriminate the different conditions under which that iron acts, the more truthfully shall we able to guess at the conditions which nature imposes upon that iron

Dr. Wm. E. Geyer—I would like to ask Professor Ryan (if he will be kind enough to turn to the chart showing the primary electromotive force) if any peculiarity was ever noticed about half way up in the curve of the primary electromotive force; a sudden departure from the smooth curve.

Professor Ryan—Yes; as I think of it now.

Dr. Geyer—Last May and June there was made, under my general supervision, a very similar experiment, where, however, we used a condenser, and discharged the condenser through a galvanometer, and in that way measured the relative dimensions of the electromotive force. We also got curves which were very smooth indeed (we took points more numerous than those that are drawn on the chart before us), until we got to a point about half way up, where we obtained results which at first we thought irregular and accidental. We skipped that part of the curve and went further up, when again it was extremely regular, until we got down on the other side to about the same height, where again the irregularity began. The irregularity was so precise that it meant to my mind that it was not a simple accident of the experiment. We then took especial pains to determine points extremely near together just in that region, and persistently obtained a very decided jog in the curve; that is, a sudden upward motion, and a sudden downward motion, at the end of which the perfect regularity of the curve was resumed; and on the other side again there was the same irregularity, and the same jog on the lower curve again. I have not found any satisfactory explanation as to the cause of it. If any could be offered by any one present it would be very interesting. I might mention in addition that when these same curves were determined on an open circuit, or on a non-inductive resistance, the irregularities were not noticed. They were only noticed when the transformer was a part of the main circuit.

Mr. Tesla—May I ask whether the machine was run at a constant number of alternations all the time?

Dr. Geyer—The machine was run at constant alternations—the regular commercial speed.

Mr. Tesla—I think if the number of alternations had been varied, greater irregularities would have been observed. I think it will be found that if a higher number of alternations had been chosen, the irregularity would have been more pronounced, until a certain limit was reached. I have run them as high as 150,000 alternations per minute. Where the alternations were very low the irregularity disappeared; but when the same number of alternations, with a longer magnetic circuit in the transformer was employed, they would again appear. So that, as I know that the magnetic lag was varied by the length of the magnetic circuit, I assume that this was the cause of the irregularity. Mr. Kennelly has very ably, and rightly, brought up the importance of the study of hysteresis. I think this is a field in which we should all work and achieve considerable improvement; so much so that certain of my experiments have been rather surprising; and in investigating the cause of the lag of the iron we will find the experiments not only of value to investigators but of real value to us practically.

Mr. Joseph Wetzler—In reference to the remarks made by Dr. Geyer as to the cause of the notch in the curve, it seems to me that it might principally be due to irregularities in the nature of the field. The field poles may have different intensities over different parts of the surface, so that if more strongly magnetic all around the edge than at the centre they would produce an irregular field, which would cause a corresponding effect in the current produced; so that all of the curve would not be regular.

Mr. C. O. Mailloux—I am inclined to believe that the theory advanced by Mr. Wetzler is the correct one; and I think that the notch in the curve is accounted for by the dynamo, rather than by the reaction of the converter upon the impulse. The fact is, that in a dynamo we never have a uniform distribution of the lines of force, from the very fact that towards the centre, the lines of force are more dense than in the area which is contiguous to the edges. The consequence is that when a coil is approaching the edge of the pole it is approaching a spot where the lines of force are more dense; and after it has passed that spot it finds itself in a place where the lines of force are not so dense. It again meets towards the middle of the pole, a place or period where the lines are denser; and again as it comes to the outer edge, a place where the lines of force are not so dense. Now, if you bear in mind the fact that the lines of force are merely the exponents or indicators of the condition of the magnetic medium, showing that there is a highly elastic substance under great stress or tension there, then we may replace those lines of force by elastic substances; and you will find on theoretical reasoning that you would naturally expect that the action of the wire, the moment that it begins to have the current in it, would be reacted upon the lines of force and displace them at that point. We know that such is the case in continuous current dynamos, but not with alternating currents. We know that the lines of force are distorted and thrown out of their course by the action of the current in the armature itself. Professor Elihu Thomson has shown by experiments that there is such a crowding effect on the lines of force that, as a matter of fact, the area of the coil, or the contour of the coil, encloses a smaller area of them than the area of the pole possesses. I should imagine that the notch in the wave of the impressed electromotive force would be due to the fact that, as the current approaches, it first meets with an obstruction which is too stiff for it to bound over, and therefore immediately quits the line of force, creating a high tension, which produces a higher electromotive force. Then we come to a place where the field is more uniform, and consequently we get the action which we would naturally expect—a current more nearly uniform, and at a rate more in accordance with some fixed law. Then as we come to the outer edge we must pass through another crust of the lines of force, and we would naturally expect to find another big break and a slight up-wave. Pursuing the same reasoning you will find that this would take place just exactly as Mr. Geyer has found by experiment; and that the speed at which the alternations occur have a great deal of influence upon that. I should have expected that the loss of force, being like all electric substances, more brittle to a rapidly acting force, would show that effect more perceptibly at higher alternations than at lower ones.

Mr. Tesla—Just a word before you pass to another subject. That opposition which was alluded to as occasioned by the dynamo machine might not have its cause in the machine; but that very kind of opposition may exist in the transformer itself; and there is where I believe it does exist. I was some time ago engaged in some work in getting direct currents from an alternating current; and I found that I was able to produce a preponderance of current impulses in one direction over those of another; and then I found that under certain conditions an opposition appeared, exactly as was stated by Mr. Mailloux in regard to the dynamo machine; and that such conditions can be brought about; and that they depend greatly upon the iron, on the number of alternations, and the length of the magnetic circuit. Imagine, for instance, that you have in the magnetic circuit of the transformer magnetism in one direction set up; certainly if such magnetism exist it will oppose the passage of a current of a certain direction; and in this way a certain modification of the curve would be brought about.

Mr. Mailloux—I am very glad that Mr. Tesla spoke of that. I might have gone farther, and said that undoubtedly the same phenomenon would occur in the transformer core itself, and that there would be changes of magnetism there under different circumstances; that inasmuch as he has so much more ably explained it than I could, I need not refer to it again. The only other point I wish to advert to is in connection with some of these curves. I would like to ask Professor Ryan whether he has taken the trouble to follow the concomitant variations of the values of the inductance; that is to say, the instantaneous values that we are supposed to get for the inductance at different variations of the electromotive force; so that we might be able to get a means of comparison between theory and practice. As we all know, the theory of the transformer is one thing, while the practice is another thing, quite remote and apart from it; so much so that the theory, although it is not yet complete, is already behind the times. We know also that that innocent looking symbol designated by L, which represents the inductance in a transformer circuit, does not happen to do so in the transformers which we use in practice. It does so on paper, and in mathematical equations, and also in transformers which have no iron. Now it would have been quite interesting if Professor Ryan had undertaken either to calculate or derive the value given for the inductance; so that we might from that calculate the impedance of the circuit; or, in other words, that spurious resistance factor by which we must multiply the square root of the current in order to get the energy that appears in the circuit.

Professor Ryan—If I have understood Mr. Mailloux's question I will answer it in this way: That if you take what is the accepted theory of the transformer up to date, and which assumes always, I believe, that the relation of the current and magnetism of the iron is the same in an up curve, as it is going down; taking that theory as it has been elaborated, and the suggestion made by Lord Rayleigh about a year ago, that is to say, taking the transformer and observing the relation of the magnetism of the iron corresponding to any particular number of ampere turns going up and coming down, to modify that theory (because it is not always the same), and when you have measured the difference that exists in going up and coming down, you will get exactly the state of affairs that are here found actually to exist. The suggestion that was made by Dr. John Hopkinson in a note published in the Proceedings of the Royal Society a few years ago, made a faint suggestion that if you assume *this* curve, and substitute for that curve a curve as modified by the values which you obtain in hysteresis, you will get precisely this state of affairs. One thing more with regard to the method by means of which you can express the exact shape of those curves mathematically, and therefore proceed by means of mathematical investigation, and by means of the impressed electromotive force that we have here given, to find what it is, and what should follow: I will say that Mr. Merritt has carefully analyzed the properties of those curves, and has shown that the impressed electromotive force curve is made up, in the first place of a sine curve in unison with it, and another curve of the third order running along like *this*, and finally one of the fifth order; and if we should carry it one further we should find with it one of the seventh order—in odd orders, the even orders having disappeared, or else the magnetism would be heavier on one side than on the other. But matters of that sort are very technical; and I did not think that these curves, representing the constituents of these various curves, would be of much interest, or I should have brought them with me.

Mr. E. G. Acheson—I understood Dr. Geyer, in speaking of the notch in the curve, to say that he obtained it only when he had the transformer in. That being the case it could scarcely be due to the machine.

Dr. Geyer—The notches were not obtained when the dynamo was run on an open circuit.

Mr. Kennelly—In that case, I venture to say that it must be due either to the magnetic lag, or else to a variation in the self-induction. If the processes of self-induction were variable it might be expected. With such variations it is probable that such kinks would follow.

Dr. Geyer—Am I right in understanding Professor Ryan to say that the efficiency of the transformer was 85 per cent.?

Professor Ryan—Eighty-six and six-tenths per cent. when working with ten lights in the secondary.

Dr. Geyer—Was that efficiency tested also in some other way?

Professor Ryan—No; it merely came in as a secondary matter.

Mr. Mailloux—It strikes me that Doctor Geyer knows more than he wants to tell us about the transformer tests. I have been told that some extensive work has been going on at Stevens Institute, and it would be interesting to get some information about it.

Dr. Geyer—What I could say about it has already been published in the journal of the Franklin Institute. It would have been read before this Institute, except that it came late last year, in June, before the summer vacation; and there were so many other papers that it was crowded out. The other tests we made, are very much like those of Professor Ryan, except that we used a condenser as a means of measuring the electromotive force; and we worked a 20-light transformer instead of a 10-light; and the mechanism for taking off the instantaneous electromotive force was slightly different. It is hardly worth while to go through details, as a larger part would be repetition. I have not seen anything in Professor Ryan's charts that differs from those that we obtained. So far as I can see, the results are essentially of the same nature.

The Chairman (vice president T. C. Martin)—I understand that Mr. Stillwell, who is Mr. Shallenberger's associate, is here, and if he is moved to speak we would be glad to hear from him before the meeting is closed.

Mr. L. B. Stillwell—The work that Professor Ryan has introduced to-night is in the general line that we have been working on for two or three years. I had not intended to add anything to the discussion, but there is one point that I might mention which may possibly be of interest, and that is, that we have noticed the point to which Professor Ryan referred in the case of a 10-light transformer, wherein he found that the loss due to the iron decreased as the load is added to the transformer. We have observed that this decrease is more marked in the case of a small one. In a 40-light transformer the iron loss is more nearly a constant; and it seems to me that this fact is in the line of the explanation which has been suggested, as to the shaking out of the magnetism, and the consequent decrease of loss in iron at heavy load in small-sized transformers, as larger ones would be somewhat less liable to mechanical vibration.

If I have understood the diagrams correctly, there is one other point which differs slightly from the observations I have made, in which observations, however, I used the divided electro-dynamometer method of measuring the angle of lag. Of course, that method is based upon the assumption that these are sine curves. Applying that method we have found that the lag factor, or co-sine, is somewhere in the neighborhood of 70 degrees; and as load is added to the secondary the factor increases more rapidly, than shown by the curves that Professor Ryan has drawn. For example, with five lights on the secondary I have found that the primary and secondary currents are practically 180 degrees apart, the co-sine of the angle of lag being about 98 degrees. With that explanation the discrepancy may possiby be due to the irregularity of the primary current, as the diagram by Professor Ryan shows.

I will say that we have also quite recently adopted a method of drawing an accurate diagram of the wave E. M. F. The method is due to Messrs. Scott and Morris, of our laboratory. I have not applied it yet, and have not seen it applied to the purpose of noting accurately the form of wave derived from our ordinary machines, since we have been more especially engaged on new types and various experimental work. The method, however, would afford a very ready means of checking up this observed kink in the curve; and I shall take the trouble to make experiments as soon as possible to throw light on that point. The method in question consists simply in mounting upon the armature shaft a wooden disc with a metallic contact at one point in the periphery, this point being connected with one terminal of a voltmeter, while the other terminal of the voltmeter is attached to one collector of the dynamo. A brush that is connected with the other collector touches the metallic point on the disc once in each revolution. By altering the position of the disc we can get a potential reading on the voltmeter proportional to the electromotive force developed by the machine at any given position of the armature, and moving it gradually through 180 degrees we have obtained surprisingly accurate results—the quantity of current through the voltmeter being large and the time being very slow. The cards I have seen made out in the last week are very accurate, and show perhaps 40 points on a phase diagram. I regret that I have none of the cards here, as they might be interesting in connection with the points brought out.

I would like to add one observation, and it is with regard to the observed efficiency of the transformers. It is, of course, understood that the efficiency of a small transformer is necessarily much less than that of a large one. The conditions heretofore have been such as to compel the use of small transformers, but the tendency as we observe it is very largely towards the use of larger ones. This tendency will do away in a great measure with the implied criticism upon the efficiency of the transformer system.

Dr. Geyer—I might say that three years ago, when the then existing methods of measuring the efficiency of such apparatus were very uncertain, we resorted to some heroic treatment of it. We stripped the transformer of its outer coil (which I think has not much to do with its efficiency) and the whole transformer was immersed in kerosene oil, and the transformed current was also used up in a calorimeter, consisting of a jar of kerosene; and then we found that as the load was increased the proportion of heat in the calorimeter to the total heat produced, was less and less as the load was made greater and greater.

Mr. Tesla—Mr. Stillwell has alluded to a method of tracing the wave. I would like to ask the members if any of them have ever made an attempt to find out whether there is a difference when the laminated sheets of the transformer are loose or tight, and if not I wish some one in his idle hours would investigate that; because I have reason to believe that there is a difference when the sheets are tight and when they are loose. Of course, it might be due to the imperfect contact of loose sheets, which would tend to diminish or increase the circulation of Foucault currents.

Adjourned.

ELECTRICITY AND LIGHT—"EXCELLENT FOOLING."

It is beyond doubt that if the world were obliged to wait till it learned what anything is in its real nature before making use of it, all civilization would vanish. Electricity demonstrates its deadly reality every day before our eyes quite as convincingly as if we knew what it was; and yet the recent discovery that it is identical with light, excepting only the rate of its vibrations, is interesting, although it adds little to the sum of our positive knowledge so long as we do not know what light is. Electricians say that if they can only succeed in increasing the rapidity of the vibrations of the unnamed something, they can give us light directly, without the intermediary stage of heat-production, which consumes an enormous percentage of the power directed to the production of the electric light of the present day. If they can quicken the vibrations till they shall penetrate glass with the velocity of the light vibrations, they will then be able to light up the whole earth. This seems promising, but the promise is tempered by a trifling doubt. What if, after the vibrations of this slow electricity shall be quickened to the velocity of light, the electricians, in the very moment of supreme success, should find that they had left in their hands nothing but the old-fashioned light after all? That would be a mortifying outcome of so much patient toil, and they might in that case doubt whether it had been worth while to go through so much to learn so little. Nevertheless, the course of experimental science must be watched with interest, even by minds held in readiness to suspect in the end a condition of things like unto that of the dog who dropped his piece of meat into the stream in order to seize its reflection in the water.

Certainly if electricity ever shall be quickened into light, this town will become a far safer place of habitation than it is now, when one scarcely ventures to put a latch key into his own door. The worst that could happen to peaceful citizens in that day would be to become "Dark with excessive bright," and excess of light does not seem to be quite so dangerous as excess of electricity. The experimenters may proceed along the line of light, then, unchecked by any criticism of ours. Perhaps, after all, this may be the only way of stopping the ravages of the deadly wire, and if so everybody will help gladly to quicken the vibrations, though the electric companies be left at the end with nothing on hand but a lot of the common, cheap sunlight which now we so carefully shut out. Who knows but if that sunlight should be brought into our houses in tubes or along wires, turned on or off at will, metered, and paid for, our people might not be induced to use it more freely? If quickening the vibrations is thus to result in increased respect for the sanitary effect of light, and decreased risk from the lethal effect of electricity, it is on all accounts desirable that the vibrations should be quickened.—*N. Y. Evening Post*, Dec. 2.

THE FORTH BRIDGE AND THE EIFFEL TOWER.

On Friday, December 6, Mr. Frederic E. Thomasson, C. E., delivered a popular lecture to a select audience, in Worcester, on the above subject. The lecturer endeavored throughout to simplify his descriptions of the details of the two engineering structures by means of a series of elaborately colored diagrams. The lecturer exhibited elevations of the whole Forth Bridge and the Eiffel Tower, to a scale of 10 feet to the inch, so that the audience might easily grasp their relative proportions. After fully eulogizing the great labors and successes of Mr. B. Baker, the lecturer proceeded to complain of Mr. Baker's comparison of the Eiffel Tower with the Forth Bridge. Mr. Baker, he said, placed the tower horizontally, and then found it considerably shorter than one of his own cantilevers. The lecturer stated that a Forth cantilever was composed of two distinct brackets, both alike, and braced back to back above the four masonry piers, with a united length of 1,360 feet; but he held it the only fair comparison to employ two Eiffel Towers, upset them, brace them also back to back at the feet, and put their united 2,000 feet against the other 1,360. In other words, the one tower in Paris, compared favorably with one-half of a cantilever, or Forth Bridge bracket. The Forth Bridge had six such brackets, and he could only accept six Eiffel Towers in comparison. Of course, as a whole, the Forth Bridge puts the Paris tower completely in the shade—still the lecturer maintained that M. Eiffel had shown in his remarkable undertaking more science and neater skill than was displayed in the great Forth Bridge. He drew special attention to the hydraulic jacks placed under the feet of the Eiffel Tower, by means of which it could be lifted or depressed in correction of any tendency it might have had to lean during building.—*Industries.*

STORAGE BATTERY THEORY.

At a meeting of the International Society of Electricians, held in Paris, on the 4th of December, M. Drezwiecki presented a new theory of accumulators in opposition to the usually accepted theory of double sulphation. According to him a hyposulphate of lead is formed which becomes reduced again when the battery is discharged. The enunciation of this theory was received with great opposition, particularly by M. G. Roux, who stated that a hyposulphate could not exist in the midst of acid, and by M. Faure, who thought that the double sulphate theory, with all its faults, was better than the new one. M. Sarna afterwards presented some results of the electric lighting of trains by means of accumulators. He enumerated the various advantages of this system, and gave the average cost on the North of France railway at 0.006 francs per 8 c. p. lamp per hour, or about two-thirds of the cost of the best oil lamps.

ELECTRICAL INDUSTRIES IN THE ELEVENTH CENSUS.

Mr. Robert P. Porter, Superintendent of the Eleventh Census, has issued the following important letter to all persons interested in the electrical industries of the country:—

"I beg to inform you that under the authority conferred by Act of Congress, approved March 1, 1889, Mr. Allen R. Foote, Cincinnati, O., chairman of the Committee on Data, and of the National Committee on State and Municipal Legislation, of the National Electric Light Association, has been appointed a special agent of the census, to have charge of the statistics of the electrical industry. The special agent is authorized to conduct in his own name correspondence relating to this industry, and, under the direction of the superintendent of census, to pursue special inquiries into the condition and tendency of the industry placed in his charge.

"It is the purpose of this office, without seeking data which may be irrelevant or unimportant, to make the statistics of this industry complete and accurate, so that its real condition and true importance may be known and understood by the general public.

It is confidently believed that those who are to derive the chief benefit of the inquiry—manufacturers and central station companies engaged in the distribution of electrical currents for the commercial uses of light and power—will lend their cordial aid to render that result full and reliable. A formal response to the questions of the schedule is all that can be insisted upon, but the superintendent solicits beyond this the hearty co-operation of all persons interested both in respect to furnishing information promptly and accurately and in the suggestion of pertinent and useful lines of investigation. Without such co-operation intelligently supplied, the inquiry must, of necessity, be limited in its value.

"All persons to whom inquiries may be addressed are assured that the requirements of law, that answers to census inquiries shall be treated as strictly confidential, will be faithfully observed. Each employé of the census office specifically makes oath not to disclose improperly that which he ascertains; and severe penalties are imposed for a violation of the obligation to secrecy. Consequently all persons addressed may have confidence that their compliance with the requests for information as to certain details of their business will in no case be followed, either in the report of the special agent or in the tabulation of results, by the disclosure of matters which they properly desire to withhold from publicity.

"The census of 1880 makes no mention of the industry of generating and distributing from central stations electric currents for the uses of light and power. The investigation of this industry for the eleventh census will be the first official census report made on the subject in this or any other country.

"For this reason it is particularly desirable and essential that the investigation shall not only present a correct record of the industry as it exists to-day, but that it shall so classify and arrange the information as to render it serviceable as a basis of action and comparison for all future reports. In view of these facts the importance and value of such an investigation and the official publication of its results should in itself be sufficient to secure from every person addressed a special effort to answer fully and promptly every inquiry. The exhibition of the birth of an industry and its growth to the magnitude of an interest second to none in importance within the short space of a single decade is a marvelous record of progress. In no other industry and in no other country has such a record ever been made."

COLLEGE NOTES.

Harvard University.

On December 2d, Professor Trowbridge delivered a very interesting lecture on "The Nature of Electricity," before a large audience. The lecture was given by invitation of the Harvard Electric Club, which now numbers over 60 members.

Professor Trowbridge began by saying that during the last hundred years there had been three great generalizations in physical science. Two of these, the law of conservation of energy, and the law of gravitation, were of Anglo-Saxon origin; the third was due to a German physicist,—Hertz. This third generalization taught that light and electricity are really the same, deriving their energy from the sun. To it the lecturer wished to call attention, and to repeat in some measure the experiments through which it had been established.

As introductory to these experiments, the lecturer spoke of the researches of Faraday, Franklin, and Henry, and showed how near they came to this discovery. Then photographic views were projected on the screen, showing the oscillatory nature of the discharge of a Leyden jar, and the elasticity of the medium through which it takes place. It was shown that a wave motion can be made to take place between two Leyden jars, and that to do this the jars must be in tune with each other. The analogous phenomena of resonance and the measurement of sound waves, were spoken of. By means of a large tuning fork, a horizontal cord was set vibrating, so as to produce wave motion with a node at the centre. A blind man might pass his finger over the cord and tell how it vibrated; in just that way, Hertz with his loop of wire, or "electrical eye," had found out the character of electrical waves. A reproduction of Hertz's apparatus was exhibited, and some of the experiments performed. It was shown that these experiments confirm the mathematical researches of Clerk Maxwell. In closing, the lecturer projected upon the screen a handsome photograph of the sun's corona, as it appeared in the last eclipse, and noted the apparent north and south poles upon it.

In the various courses in physics there are 236 men, and of these over 200 are pursuing the laboratory courses.

On December 4th, Mr. J. C. Wait, of the Lawrence Scientific School, gave an interesting talk on "Practical Points in Electrical Engineering," before the Electric Club.

At Professor Trowbridge's lecture, an electrical machine made especially for the college by Benjamin Franklin, was shown. It consists of a globe, about a foot in diameter, made of some dark substance, and turned by an elaborate wheel and crank arrangement. It is mounted on large pole-like supports, and covers in all, about 4 x 7 x 5 feet.

Massachusetts Institute of Technology.

Mr. Hollis French, '89, has entered the electrical engineering business, associating himself with two other "tech." graduates, under the name of the Massachusetts Electrical Engineering Co. The object of this company is to act as a mediator between manufacturers and purchasers; also, to investigate patents with respect to validity and practical utility, and give advice upon electrical matters generally. The company has engaged the services of several prominent experts in electrical and mechanical matters as consulting engineers.

The following instruments have been added to the laboratory equipment recently:—a very sensitive reflecting galvanometer, by Carpentier; a milliampere balance of Sir William Thomson's form, by J. White; a reflecting galvanometer of the Hartmann form, designed by Mr. Puffer.

Through the courtesy of the Electrical Club, of Harvard College, the members of the Technology Electric Club were invited to listen to a lecture given at the Jefferson Laboratory, December 2, by Professor Trowbridge upon "The Nature of Electricity."

After two years of publication the *Technology Quarterly* has ceased to exist. This journal, designed as the exponent of the scientific work of the school, deserved a better fate, after the earnest work of the under-graduate editors and the active interest of the professors. Lack of financial support was the cause of the discontinuance of the journal.

Mr. Stephens, instructor in mechanical engineering, has resigned after seven years of service. He will be succeeded by Mr. Miller, '86, now instructor in the mechanical engineering laboratory. Mr. C. A. French, of the department of mathematics, has also resigned.

Twenty-seven members of the Technology Electric Club dined Friday, December 13, at Young's Hotel After dinner President Carlisle announced from the head of the table the object of the business meeting and presented Mr. G. E. Hale, '90, who opened a discussion upon the establishment of the club upon a permanent basis. Following Mr. Hale, various members of the club expressed their views. The general sentiment was averse to any action at the present time.

POINTERS.

.... INSURANCE companies are suspicious of electric light plants and electric wires, and are inclined to base high rates of premiums on their fears. It is good economy to show by results that the underwriters are mistaken.—*C. C. Haskins.*

.... IT is sometimes forgotten that it is almost never the solver of a difficult problem, but really the propounder of the problem, who is an inventor.—*John Perry.*

.... THE electric motor driven from a current produced by water power is as near the fountain head of natural energy as is the steam engine.—*R. W. Pope.*

.... THE progress of science is not so much that of an army as a crowd of searchers, and that a call in the false direction may be responded to, not by one only, but by the whole body.—*S. P. Langley.*

.... SAFETY and danger are terms which have not an absolute, but only a relative, meaning. To permit the wholesale introduction of overhead wires by an unlimited number of companies, good, bad and indifferent, throughout London, would certainly be extremely unsafe; but to permit a few responsible companies, accustomed to good work, to put up a limited amount of overhead wires need not necessarily involve any great danger to the public.—*Industries.*

.... A KNOWLEDGE of what is meant by amperes, volts, ohms and watts, cannot be obtained merely by listening to lectures or by reading. Just as a little use of a watch, of a two-foot rule, and of a spring-balance give exact practical notions of the measurement of time, of distance and of force, so the use of an ammeter and voltmeter will give exact practical notions about Ohm's law and electric measurements generally.—*John Perry.*

.... IN every direction the interests of the public are being criminally neglected through the ignorance of public authorities, and the blindness of their constituents. Property and energy representing millions upon millions of dollars are wasted yearly, which might be saved by heeding the advice of trained engineers. —*R. W. Pope.*

.... IF there is any one thing in the whole business of electric lighting for which I have the most thorough and uncompromising dislike for testing circuits, it is the magneto-bell.—*C. C. Haskins.*

.... THE great majority, even of the students of science, must take their opinions ready-made as to science in general; each knowing, so far as he can be said to know anything at first hand; only that little corner which research has made specially his own. —*S. P. Langley.*

OBITUARY.

E. N. Dickerson.

The death of Mr. E. N. Dickerson, which occurred at Far Rockaway, December 12, leaves a void in electrical circles second only to that caused in the legal profession. Devoting himself at an early period of his career to the practice of patent law, he soon acquired marked distinction in that branch of his profession; a distinction largely due to his scientific and technical knowledge, acquisitions which, united with his unusual faculty of insight and discrimination, and supplementing his legal training, qualified him to take a leading part in legal contests over patented inventions. The science and the arts of electricity attracted his attention and interest in an eminent degree, and it is mainly through the prominent part that fell to him in much of the most important electrical patent litigation of recent years that Mr. Dickerson became so well known and so highly valued by electrical inventors and engineers.

E. N. Dickerson was the son of Philemon Dickerson, Governor of New Jersey in 1836, and was a nephew of Mahlon Dickerson, also governor of that state, and sometime secretary of the navy. He was graduated from Princeton College when but eighteen years old, and three years later was admitted to the bar. After a few years he gave up practice for a time to devote himself to scientific studies and foreign travel. Upon his return he took up his law practice in this city, and started forth in his brilliant course as a patent lawyer.

Mr. Dickerson was a man of striking figure, being much over six feet in height and of robust appearance. Like most big men he was genial and warm-hearted. He not only gave sympathy but expected it. A noticeable trait in his character was his habitual reaching out to others for intellectual appreciation of his work for the time being and participation in his absorbing interest in it. The strong and witty things he did and said were many. He was an artist in denunciation, and scarcely less so in encomium.

Mr. Dickerson has recently been directly interested in electrical industry, having become the President of the "C. & C." Electric Motor Company, of this city.

He was a vice-president of the New York Electric Club. At a meeting of the Board of Managers, held December 19, the following resolutions were adopted :—

> *Resolved*, That in the death of Vice-President E. N. Dickerson the Electric Club loses a valued and highly esteemed officer, a gentleman of great ability, scientific attainment and vast general information, and whose kindly nature made him the friend of everyone and everyone his friend who had the pleasure of his acquaintance.
>
> *Resolved*, That this resolution be spread upon the minutes of the Club, and a copy of the same be suitably engrossed and forwarded to the family of the deceased, and also that copies be furnished to the principal electrical and scientific papers.

Mr. Dickerson left a widow and one son, Edward N. Dickerson, Jr., who has been his law partner. The United States Courts in this city adjourned on December 12 when his death was announced, as a mark of respect for his memory.

Miles W. Goodyear.

Mr. Miles W. Goodyear, who had been in poor health for a long time, died suddenly December 15. A disorder of the heart is thought to have been the cause of his death. It would not be easy to point to a figure better known in electrical trade circles than that of Mr. Goodyear. For some twenty years he had been the manager of the electrical department of L. G. Tillotson & Co., and their successors, The E. S. Greeley & Co. Aside from his business qualifications his geniality, affability and good fellowship had made him a host of friends, who will feel a marked personal loss in his untimely death at the age of fifty years.

At a meeting of the Board of Managers of the Electrical Club, of which Mr. Goodyear had been a member since the organization of the club, December 19, resolutions were voted as follows :—

> *Resolved*, That in the death of Miles W. Goodyear this Board has lost one of its most earnest, intelligent and popular co-workers; one who has ever labored enthusiastically for the best interests of the Club which he helped to organize. We found him ever faithful and true, and keenly and deeply regret our loss.
>
> *Resolved*, That this resolution be spread upon the minutes of the Club, and a copy of the same be suitably engrossed and forwarded to the family of the deceased, and also that copies be furnished to the principal electrical and scientific papers.

THE DOWN-TOWN EDISON STATION DESTROYED BY FIRE.

Fire was discovered in the Pearl street station of the Edison Electric Illuminating Co., New York, about half-past six o'clock in the morning, January 2, and spread with such rapidity that the interior of the buildings and the entire apparatus of the station were destroyed within an hour. The station occupied two old buildings, Nos. 255 and 257 Pearl street, and was the earliest central station of importance in the world for the distribution of incandescent electric light over a considerable area. It was the only one of the several Edison stations in this city not housed in a fire-proof structure. It is particularly unfortunate that its destruction should occur after seven years' continuous service—and while the Edison Electric Illuminating Co. were perfecting plans for rebuilding and fire-proofing the premises during the ensuing spring.

The station was equipped with eight of the huge Edison dynamos, and supplied current for 18,000 to 20,000 lamps in the down-town district, bounded roughly by Spruce street, the East River, Beaver street and Broadway. For a few hours there was a total cessation of service, but through the energetic action of the company a partial service was established from the auxiliary station in Liberty street, about eleven o'clock, and by four o'clock in the afternoon a very considerable portion of the district was supplied from that partially equipped station.

Vice-president and general manager John I. Beggs, was promptly on the ground, directing the removal of the debris, ordering the immediate shipment of new dynamos from the machine works at Schenectady, and planning for a temporary equipment to be set up immediately in the lower part of the ruined buildings as soon as the wreckage can be cleared away. Two dynamos were on the way to New York before nightfall, and Mr. Beggs expressed his confident expectation of resuming full service within three days.

The station buildings were owned by the Edison Electric Illuminating Co. Mr. Beggs estimates the company's direct loss by the fire at $30,000 to $50,000 on the buildings, and $100,000 on the station equipment and supplies. The company holds insurance of $30,000 on the buildings and of $81,500 on machinery and stock.

The installation of the Pearl street station was completed in the autumn of 1882. The machinery was started for the first time on the afternoon of September 4, supplying 85 buildings wired for 2,323 lamps. In April, 1884, the service had grown to 500 buildings and 11,272 lamps. The plant has not been idle a day or night since it began operation.

The fire was discovered in the dynamo room. Its cause is still a matter of conjecture.

THE TELEPHONE.

On the 3d of December, before Judge Taft, of the Ohio Supreme Court, the Cincinnati and Suburban Telegraph and Telephone Association began suit for an injunction against the Mt. Auburn Electric Railway Co. to restrain that company from operating its cars by the single trolley lines now in use, because of its injurious effects upon the telephone service. The case is a distinct attack upon the single trolley method of electric railway operation, and its result will be looked for with much interest in telephone and street railway circles.

The hearing of testimony was concluded on the 18th of December, and the arguments of the counsel on both sides occupied two days, the 20th and 21st. The long documents, manuscripts and the testimony in the case were then given to Judge Taft, whose decision is not yet announced.

Foreign.

France.—From Paris despatches it appears that the government has issued new regulations for improving the telephone service recently taken over by the state. A new scale of charges has been arranged as follows :—For the use of a post-office telephone cabin in Paris, 10 cents for every five minutes; elsewhere, 5 cents. The use of a telephone line between two towns is to be charged for at the rate of 15 cents for every hundred miles for five minutes' service. Persons having telephones at their houses may use the long-distance lines at the same rates. No alteration is made in the charge for telephone messages between Paris on the one hand and Brussels, Lyons and Marseilles on the other, which remain at 60 cents, 40 cents and 60 cents respectively. Villages where no telegraph office exists may erect a telephone line at their expense connecting them with the nearest telegraph office, and send and receive telegrams without extra charge.

Austria-Hungary.—The opening of the new telephone line between Buda Pesth and Prague led to so much disputing as to the language which should be used by the employés that it has been decided to use French. By this means alone could the rival claims of Czechs and Magyars, Germans and Poles be satisfied.

Austria.—What is said to be the longest telephone circuit on the continent of Europe, was opened to the public on the 20th of October. The line is from Vienna, in Austria, to Leipsic, and every word could be perfectly understood and the voice recognized without difficulty. The distance between the two cities by rail is something less than 300 miles, but the telephone wires are strung along the highways, and the actual distance on these routes is near 350 miles.

PERSONAL MENTION.

Mr. Carl Hering was handsomely entertained at a banquet given in his honor at the Café Robinet, Boulevard Montparnasse, soon after the close of the Paris Exposition. He was invited to meet some of the leading and most distinguished electricians of

Paris, on this occasion, as was most fitting and appropriate. The Café Robinet is the head-quarters of the electrical society "de la Planché."

Amongst the guests were such men of note as Potier, Napoli, Richniewski, Avizard, Serpollet, Abdank-Abakanowicz and Soulages, no fewer than 11 nationalities being represented and meeting to do honor to Mr. Hering. Among our own countrymen were Messrs. Meech, Thurnauer and Bishop, representing important electrical interests in the United States. The proceedings and speeches were of a high order, and the guests separated at a late hour, with evident appreciation of the elegant hospitality of the French *savants* to their professional brethren.

Mr. J. H. Longstreet, for several years engaged in the manufacture of electrical instruments in this city, has recently purchased the Riverview Iron Works, at Bordentown, N. J., where he has opened business in foundry work, machinery, etc. For a few years past he has been devoting his attention to agriculture.

Mr. E. T. Gilliland, president of the Electric Club, of New York, who is compelled by ill-health to seek a southern climate for the winter, tendered his resignation, in a letter expressing his deep interest in the club and its future work, and enclosing a pledge of substantial financial aid.

At a meeting of the board of managers of the club, held December 19, the following resolutions were unanimously adopted :—

> *Resolved* :—1st. That we learn with extreme regret of the illness of our honored president, and while accepting the resignation which his illness compels, we desire to testify to our appreciation of his earnest work in behalf of the club, and to express our thanks for the substantial subscription which accompanies his letter of resignation, and which is only one of many favors the club has received from him. We sincerely hope for his early restoration to health.
>
> 2d. That, desiring not to lose Mr. Gilliland's valuable assistance on this board, should he be able to meet with us on his return from the south, we unanimously ask him to remain as vice-president of the club.

At the same meeting, Mr. O. E. Madden was unanimously elected president of the club, to fill the unexpired term.

Mr. Ira Cornwall, Secretary of the St. John, N. B. Electrical Exhibition Committee, on December 21st, received from the committee a highly complimentary letter, accompanied by a gift, consisting of an elegant clock and bronze ornaments, the whole expressive of the committee's appreciation of the energetic and successful planning and conduct of the recent exhibition, which was so largely due to Mr. Cornwall's gratuitous services.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Programme for the Convention at Kansas City, February 11-14.

Mayor Davenport will welcome the Association and attending visitors to Kansas City.

President E. R. Weeks will open the Convention with a brief address.

Secretary and Treasurer Allan V. Garratt will make the usual reports.

PAPERS.

Professor Elihu Thomson. "Safety Devices in Electrical Installations."

Professor Henry A. Rowland.

Professor Rowland has kindly consented to prepare a paper based upon a correspondence with the members of the Association by the Secretary, for the purpose of ascertaining the technical questions with which they find the greatest difficulty.

Mr. Thomas A. Edison will give an address—the subject of which is not yet announced—by phonograph, which will reproduce Mr. Edison's voice loud enough to be heard in all parts of the house. As but few persons have ever heard Mr. Edison speak in public, this address from the phonograph will be of unusual interest.

Mr. Frank J. Sprague. Subject: "Electricity as Applied to Street Railways."

Mr. F. E. Sickels. Subject: "The History and Theory of the Steam Engine."

Mr. George H. Babcock. Subject: "The Economic Generation of Steam."

Mr. Myron D. Law. Subject: "Nine Years with the Arc Lamp."

Mr. C. A. Harber. Subject: "Line Insulation from the Standpoint of Practical Experience."

Mr. T. Carpenter Smith. Subject: "A Universal System of Central Station Accounts."

Mr. A. J. De Camp. Subject: "The Cost of the Products of Central Stations."

Mr. C. J. H. Woodbury. Subject: "Central Station Construction."

Mr. C. J. Field. Subject: "A Recent Edison Central Station and the Results thus far Obtained."

Mr. Henry W. Pope. Subject: "How Our Paths May Be Paths of Peace."

Mr. C. C. Haskins. Subject: "Prodigality in Economy."

Mr. E. F. Peck, in the discussion of Mr. M. L. Law's paper, will give the results of his numerous tests of arc light carbons.

Papers from several other prominent gentlemen are looked for, and will be announced later.

REPORTS WILL BE MADE BY

The Executive Committee, Mr. G. W. Hart, chairman.

Committee on Patent Legislation, Mr. Arthur Steuart, chairman.

Committee on Underground Conduits and Conductors, E. T. Lynch, Jr., chairman.

Committee on Harmonizing Electric Light and Insurance Interests, Mr. P. H. Alexander, chairman.

Committee to Confer with Mayor Grant in regard to the International Exposition of 1892, Dr. Otto A. Moses, chairman.

Committee on Electrical Data, Mr. A. R. Foote, chairman.

Committee to Memorialize Congress on the Abolition of Custom Duty on Copper, Mr. C. A. Brown, chairman.

Committee on Electrical Execution, Mr. E. W. Maher, chairman.

Committee on Standardization of Potential on Electric Street Railways, Mr. E. T. Lynch, Jr., chairman.

National Committee on State and Municipal Legislation, Mr. A. R. Foote, chairman.

ELECTRIC LIGHT AND POWER.

Mr. Orlo V. Thomas, electrician-in-charge of the electric light station at Taunton, England, communicates the following to the *Electrician* (London), November 23d, 1889:—

"It may interest you to know that an incandescent lamp (Woodhouse & Rawson), which was put up on September 22d, 1888, and which has been burning continuously ever since, has now burned out, after the phenomenal life of 10,608 hours. As this was a 98-volt lamp, and was on the charging leads of a 50-cell battery, you will see that during a considerable part of its life it was burning a good deal above its nominal candle-power."

The Louisville Electric Light and Power Co., New Orleans, La., has changed its title to the Louisiana Electric Light Co., and will increase the capacity of its plant from 2,000 arc and 6,500 incandescent lights to 4,000 arc and 40,000 incandescent. The Fort Wayne Jenney Electric Light Co., of Fort Wayne, Ind., will furnish the machinery.

The Easton Electric Co., of 45 Broadway, New York, has concluded a contract with the city of Rockland, Me., by the terms of which the company is to light the streets of that city for a period of five years. The Easton company has recently been reorganized. Its officers are :—President, P. Minturn Smith; vice-president, Wm. D. Perry; secretary, G. G. Frelinghuysen; treasurer, Charles Tremaine; electrician, James W. Easton. The management goes to work energetically, and invites investigation into its system. The electrician of the company, Mr. Easton, is well known in electric light circles through his inventions in that art.

The Heisler Electric Light Co., of St. Louis, announce that after mature deliberation they have decided to change their standard lamps from 30 to 32 c. p., and from 15 to 16 c. p., thus falling in line with other manufacturers in this respect. They have found themselves sometimes at a disadvantage where specifications stipulate the 16 and 32 c. p. lamps. They adhere, however, to their faith in the larger lamps, and will use the 32 c. p. lamp as their standard.

Wabash, Ind., was among the first cities to adopt the plan of lighting by arc lights on towers. This plan was subsequently displaced by the Heisler incandescent system, and the lights distributed through the streets of the city. For some time this plant was operated solely for public lighting, but a demand having sprung up for incandescent lights for commercial and domestic lighting, the company decided to make considerable enlargements, and placed their order with the Heisler Electric Light Co., of St. Louis, for one of their latest improved dynamos, having a capacity of 350 32 c. p. lights.

The La Grande Edison Electric Light Co., Oregon, has been organized. President, W. H. McDonald; vice-president, H. Ansen; manager, J. K. Roming. The plant will have a capacity of 800 16 c. p. Edison incandescent lamps. The station plant will consist of two Edison dynamos, driven by a 50 h. p. Ball automatic engine, with a 60 h. p. horizontal tubular boiler, made by the Ball Manufacturing Co.

Supt. J. E. Powell has made the following recommendations, which have been approved by the Secretary of the Treasury:—"It should be stated that the qualifications of persons to fill the position of chief engineer of the public buildings containing large electric lighting plants should be carefully inquired into, particularly in regard to their knowledge of electric lighting. The ordinary examination required from United States Local Inspectors of Steam Vessels, while it may protect the department from employing men incompetent as engineers, does not and cannot protect it from incompetent electricians and secure it the service of men skilled both as engineers and practiced in the management of electric lighting plants. I recommend that applicants for the positions of chief engineer and assistant engineer in public buildings, having electric lighting plants owned by this department, be required to present satisfactory evidence of their ability to operate electric lighting plants in addition to the requirements ordinarily exacted of the engineers."

Foreign.

Mexico.—Mr. Theo. Plate, president of the Interstate Gas & Water Works Co., of St. Louis, has recently secured franchises extending over long terms of years, for erecting and operating incandescent electric light plants in the cities of Durango and Aques Calientes, Old Mexico. In both cases the franchises are accompanied with contracts for lighting the streets and other public places. In Durango, the authorities use 200 32 c. p. lights and 150 16 c. p. lights, and at Aques Calientes, 150 32 c. p. lights and 175 16 c. p. lights. These lights are to be operated about 240 hours per month. The Heisler system of long-distance incandescent lighting has been adopted for these plants, and orders have been placed with the St. Louis office of the company for complete outfits of central station apparatus. The plants will be models in every way, and on account of the high cost of fuel, compound condensing engines of the high speed type will be used. It is expected that this apparatus will be ready for shipment in January, as the plants are to be in operation in time for the annual festivals, which take place early in the spring. Mr. Plate and his engineer, Mr. Andrews, left for Mexico on the evening of the 21st of December, to begin active operations.

MANUFACTURING AND TRADE NOTES.

The Wainwright M'f'g. Co., of 34 Oliver St., Boston, Mass., have recently furnished the following electrical plants with their corrugated copper tube feed water heaters:—Canada Electric Co., Nova Scotia, 100 h. p.; Edison Electric Light Co., Penn., 300 h. p.; No. Attleboro Steam and Electric Co., Mass., 250 h. p.; Marr Construction Co., Mass., 150 h. p.; Lewiston Electric Light and Heat Co., Ill., 75 h. p.; Belfast Electric Light Co., Maine, 100 h. p.; Denver Tramway Co., Col., 400 h. p.; Greensburg Electric Light Co., Ind., 100 h. p. The Wainwright company report business rushing in heaters, condensers, expansion joints and separators.

Messrs. J. H. Bunnell & Co., of New York, so long and well known as an electrical manufacturing and supply house, have removed to Cortlandt and Washington streets. The distance is short from their old quarters in Liberty street, and the new location is conveniently near the offices of the large number of electrical interests in upper Cortlandt street.

Messrs. Ames, Crerar & Co., northwestern agents of the Western Electric Co., have opened a general supply store for electrical goods at 51 East 4th street, St. Paul, Minn. They will keep in stock a full line of electrical supplies including insulated wires, linemen's tools, switches, cut-outs, incandescent lamps, electric bells and annunciators, batteries, etc.

They will also give attention to construction work, and will have a competent force of men to undertake all kinds of electrical contracts such as central station and isolated electric light plants, fire alarm and call bell systems, etc.

Mr. B. L. Ames, who will have personal supervision of the business of the concern, is a graduate of the Massachusetts Institute of Technology, and has had several years experience as manager of successful electric light plants, both arc and incandescent.

The Sawyer-Man Electric Co. has been given the contract for supplying lamps to the Boston post-office. It is stated that the new contract is based upon a higher price for lamps than has been paid by the post-office for lamps of other manufacture under a former contract.

The Westinghouse Electric Co.'s returns of orders for December, up to the 15th, indicate the safe assumption that as far as business is concerned, the month will prove a fitting climax of a very successful year. Among other contracts, the company obtained an order from St. Louis, Mo., for alternating current apparatus of a generating capacity of 3,000 lights; a similar order was also secured from the local company in Denver, Colorado, and a third and larger one from Portland, Ore., for 6,000 lights and 100 arc lights. The specifications of the latter contract called for special machinery of 4,000 volts. The plant is to be run by water power, which is 12 miles away from the scene of the distribution of the electric current.

The total amount of apparatus disposed of by the company during the year 1889, will aggregate a capacity of at least 250,000 lights. This figure may be better understood from the following comparison:—The company was organized in the latter part of 1886, and during the period previous to the beginning of 1887, apparatus for central station plants of a capacity of 2,400 lights was disposed of. During the year 1887, the total sale of machinery represented a capacity of 106,200 lights, and during 1888 the aggregate amount of apparatus sold footed up a total capacity of 119,950 lights.

From these figures, it is readily discernible that the business of 1889, will not only more than double the amount of business of either of the two previous years, but it even exceeds the total amount of sales made from the day of the company's organization until the beginning of the year 1889.

This record of three years is gratifying, as indicating the accelerating pace of electrical industry generally, and particularly so to the Westinghouse Electric Co. in the extraordinary rise and growth of its business.

The Willamette Falls Electric Co., of Portland, Ore., has made a contract with the Westinghouse Electric Co., of Pittsburgh, Pa., to furnish them with machinery for the establishment of a central station plant of 6,000 incandescent lights and 100 arc lamps, to light up the city. The plant will be situated at Willamette Falls, about 12 miles from the city, where the electric current is to be generated by water power. The company has ordered the Westinghouse people to make special machinery for this contract to produce a current of 4,000 volts. There will be a branch central station in the city, from which the current will be distributed. Only one arc light machine will be used for the 100 lamps, this being a dynamo of the new arc light system recently brought out by the Westinghouse Electric Co.

The Thomson-Houston Electric Co. report the following sales with the number of lights in each case.

Incandescent apparatus to central stations:—

Sioux Falls, So. Dakota, 50; Tuscumbia, Ala., 100; May's Landing, N. Y., 400; Portland, Me., 800; St. John. Mich., 500; Boston, Mass., 500; Adams, Mass., 500; Middlesboro, Ky., 300; Seymour, Conn., 500; Langhorn, Pa., 500; Plymouth, Mass., 500; E. Greenwich, R. I., 850; Oswego, N. Y., 1,300; Hyde Park, Mass., 1,300; Andover, Mass., 650; Winchester, Md., 650; Somerset, Ky., 650; Watertown, N. Y., 650; Catskill, N. Y., 650; Rochester, N. Y., 650; Huntington, Pa., 650.

Arc apparatus for central stations:—

Lowell, Mass., 25; Rochester, Md., 50: St. John, Mich., 30; Camden, Ark., 30; City of Chicago, Ill., 210: Chicago, Ill., 100; Litchfield, Ill., 50; Fairhaven, Wash., 30; Chattanooga, Tenn., 100; Toledo, O., 50; W. Superior, Wis., 50; Cincinnati, O., 200; Macon, Ga., 100; Pottstown, Pa., 50; Spokane Falls, Wash., 100; Huntington, Pa., 50; Bedford, Me., 50; Long Branch, N. Y., 100; Wilkesbarre, Pa, 50; Austin, Minn., 50; Weymouth, Mass., 60; New Haven, Conn., 50; Missoula, Mont., 50; Sedalia, Mo., 100.

Arc apparatus for isolated plants:—

Allentown Rolling Mill, Allentown, Pa., 18; L. F. Bartlett, E. Saginaw, Mich., 18; Pioneer Mining and Manufacturing Co., Thomas, Ala., 37; Merrimac Man. Co., Lowell, Mass., 45; G. F. Blake Man. Co., E. Cambridge, Mass., 30.

Incandescent apparatus for isolated plants:—

E. A. Gyde, E. Saginaw, Mich., 35; National Transit Co., Kane, Pa., 100; National Transit Co., Parker Landing, 100; Water Works building, Detroit, Mich., 100; St. Clair Hotel, Cincinnati, O., 100; Louisville Chair Co., Louisville, Ky., 200; J. O. Shoup & Co., Dayton, O., 1,600; Norfolk Woolen Co., Norfolk, Mass., 50; Wadsworth Howland & Co., Malden Mass., 50; J. W. Ayer, Brewer Village, Me., 50; Allentown Rolling Mill, Allentown, Pa., 200; White Cycle Co., Westboro, Mass., 100; Midgeley Wire Belt Co., Beaver Falls, Pa., 100; Locke Bros., Salem. Mass., 200; Woodrough & McFarlan, Cincinnati, O., 200; H. A. Marston, So. Framingham, Mass., 200; Eastern Manufacturing Co., Brewer, Me, 200.

The Westinghouse Machine Co. reported that "high-water mark" had been reached in that company's business during the month of October, 1889, the sales being the largest in the company's history up to that time, and amounting in the aggregate, including Junior, Standard Westinghouse and Compound engines, to 6,035 h. p. The month of November, 1889, however, shows even better results, with the following:—

34 Junior engines	940 h. p.
31 Standard engines	940 "
39 Compound engines	5,300 "
104 engines, aggregating	7,180 h. p.

The sales of both months are in excess of the company's producing capacity, notwithstanding the heavy additions recently made to their machinery, and the puting on of a night force. It is hoped and believed that orders will slacken up during the winter, so that the company may thus be enabled to restore the sadly depleted stock of finished engines in its warehouse.

The Sawyer-Man Co.'s factory, 510–534 West 23d street, is still overrun with orders for incandescent lamps, and although running night and day finds it impossible to keep up with the demand, being about 100,000 lamps behind their orders. Extensive additions are being made to the plant, and when completed there will be nearly 900 exhausting pumps in use.

The Crocker & Wheeler constant current electric motors are meeting with marked success for use on arc-lighting circuits and constant current power circuits. A recent order from London for twenty of these motors is significant of their appreciation in England. The motors are manufactured by the Crocker-Wheeler Electric Motor Co. The Sprague Electric Railway and Motor Co. are sole agents for their sale.

The Calumet & Michigan Telegraph Co. has been formed at Chicago, to construct and maintain a line for the transmission of all kinds of electric signals. Capital stock, $500; incorporators, Wallace Fairbank, Spencer Eddy and G. M. Glessner.

The Knapp Electrical Works, of Chicago, certificate of incorporation was issued in November. The capital stock is $100,000, and the incorporators are F. M. Knapp, M. A. Knapp and L. K. Bryeson. This establishment was formerly known as the Railway Telegraph Supply Co.

The Park Ridge Arc Light & Power Co. has been organized at Chicago, with a capital stock of $50,000. The incorporators are F. B. Clark, M. T. Cahill and Edward Slack.

ELECTRIC STREET RAILWAYS.

The Thomson-Houston Electric Co. report the following new railway contracts:—

Brooklyn, N. Y., Coney Island & Brooklyn Railroad, 16 miles; 25 motor cars.

Salem, O., Salem, City Street Railway Co., 2 miles; 3 motor cars.

Utica, N. Y., Utica Belt Line Railway, 20 miles; 25 motor cars.

The Sprague Electric Railway and Motor Co. report new railway contracts as follows:—

Kearney, Neb., 8 miles; 2 motor cars.

Denver, Col., Colfax Avenue Electric Railway, 4 miles; 4 motor cars.

Salem, O., Capital City Railway, 3 miles; 2 cars.

Sprague roads reported as constructing December 1, 1889, have since been put in operation as follows:—

Cleveland, O., Broadway and Newburgh Street Railway, 10 miles; 16 cars. Detroit, Mich., Detroit, Rouge River & Dearborn R. R., 1 mile; 1 car. Moline, Ill., Moline Street R. R., 2 miles; 2 cars. Plattsmouth, Neb., Plattsmouth Electric R. R., 2 miles; 2 cars. Portland, Ore., Willamette Bridge & Ry. Co., 1.5 miles; 5 cars. Sterling, Ill., Union Elect. R. R., 6 miles; 7 cars. Wilkesbarre, Pa., Wilkesbarre and West Side R. R., 4 miles; 3 cars. West Bay City, Mich., West Bay City Elect. Ry. Co., 5 miles; 8 cars.

Thomson-Houston roads under construction November 15, 1889, were put in operation before December 15, as follows:—

St. Paul, Minn., St. Paul & Minneapolis Ry. Co., 20 miles; 20 cars. St. Louis, Mo., St. Louis Bridge Co., 2 miles; 4 cars.

The Short Electric Railway Co. reports the following contracts:—

S. Covington and Cincinnati Street Railway Co., Madison street and Main street lines, 8 miles; 10 motor cars.

Muskegon, Mich., Muskegon Electric Railway, 4½ miles; 5 motor cars.

The Columbus Consolidated Street Railway Co. has contracted with the Short Electric Railway Co. for the track wiring for the parallel systems of electric traction.

Pittsburgh, Pa., Pittsburgh Traction Co., 2 miles; 10 motor cars; short parallel system.

Cincinnati, O., S. Covington and Cincinnati Street Railway Co., 8 miles; 10 motor cars; short double wire parallel system.

The Van Gestel Electric Street Car Company, New York, in a circular dated December, 1889, announces its readiness to give estimates for equipping railroads, lighting towns, or for individual plants, with catalogue, giving full descriptions, cuts and plans of the entire system. From the circular it would appear that the "system" of "electro-motion" consists in the use of a separate locomotive equipped with storage batteries. At any rate no peculiar apparatus, methods or details are set forth.

Salem, O.—The Electric Street Railway is under construction and making rapid progress. The road is two miles long and will be equipped with the Thomson-Houston system. Three motor cars are ordered.

LEGAL NOTES.

THE EDISON LAMP PATENT IN CANADA—IT IS DECLARED VALID.

Reversal of the Judgment of the Deputy Commissioner of Patents.

Before the Hon. John Carling, Minister of Agriculture.

The Royal Electric Company of Canada, *Petitioners*, and Edison Electric Light Company, *Respondents*.

Messrs. Z. A. Lash, Q. C., of Toronto, R. D. McGibbon, of Montreal, Curtis, of New York, and Kerr, of Pittsburgh, Pa., counsel for petitioners.

Messrs. Hector Cameron, Q. C., B. B. Osler, Q. C., of Toronto, McMaster, Q. C., of Montreal, and Grosvenor P. Lowrey, of New York, counsel for respondents.

This is a re-hearing of the case, on the petition of the Royal Electric Light Co., of Canada, tried before Mr. Richard Pope, the Deputy Commissioner of Patents, and on which he gave a decision, on the 26th February last, annulling the Edison patent, in virtue of sec. 37, chap. 61, Revised Statutes of Canada. [See Electrical Engineer, April, 1889, page 199.]

A doubt having arisen as to the jurisdiction of the Deputy Commissioner of Patents, in virtue of the provisions of the section of the act referred to, it was decided that the case should be commenced *de novo*.

A re-hearing accordingly took place before me on the 23d July last.

The evidence taken at the previous hearing, before the Deputy Commissioner of Patents, was accepted by both the petitioners and the respondents, and some additional evidence was taken. The counsel on both sides argued the question at issue, from their respective standpoints, with great clearness and ability.

In addition to the arguments at the last hearing, Mr. Lowrey, on behalf of the respondents, with consent, put in a written statement of argument, a copy of which was communicated to Mr. Lash, and to which he subsequently furnished a reply.

After a careful consideration of the evidence I decide as follows:—

(1) I find that Thomas Alva Edison, the patentee of the patent in the proceedings mentioned, did, within two years from the date of such patent, commence, and, after such commencement, did continuously carry on in Canada the construction and manufacture of the invention patented, in such manner that any person desiring to use it might obtain it, or cause it to be made for him, at a reasonable price, at some manufactory or establishment for making or constructing it in Canada.

(2) I further find that, after the expiration of 12 months from the granting of the said patent, neither the said patentee nor any person claiming or holding under him did import or cause to be imported into Canada the invention for which the said patent was granted.

I do, therefore, in pursuance of the statute in that behalf, declare that the said patent has not become null or void, and I dismiss the application of the petitioners, the Royal Electric Co., of Canada. John Carling, *Minister of Agriculture.*

Department of Agriculture,
Ottawa, 25th November, 1889.

The Hon. Sir John Thompson, Minister of Justice, sat with the Minister of Agriculture at the hearing. The following are extracts from his report on the case, dated Ottawa, 30th October, 1889, and addressed to the Minister of Agriculture:—

The nature of the petition, and of the various proceedings taken under it, down to the time when it was heard by Mr. Richard Pope, Deputy Commissioner of Patents, are recited in the decision which was rendered in this case on the 26th of February last by that gentleman. [See Electrical Engineer, April 1889, page 199.] I need not detail these matters again, because the narration by Mr. Pope indicates them sufficiently, although it will be seen that I do not concur in his conclusions as to what was established by the evidence, in regard to many important points, but arrive at conclusions almost directly opposite. In order that the explanation of the fact that the case subsequently came before us may appear in the record, I may remind you that after the decision of Mr. Pope was pronounced the respondents made application to the Governor General in Council, praying, on various grounds, that effect should not be given to that decision. The application was then referred to you and myself by His Excellency in Council, for report, and on the examination of the subject which ensued it seemed to be at least, doubtful that Mr. Pope, as Deputy Commissioner of Patents, possessed the necessary jurisdiction to hear and decide on such a petition, or to pronounce judgment upon it.

It was, accordingly, deemed best that the whole matter should be re-heard before yourself as Minister of Agriculture; and you having desired my assistance at the hearing, I had the pleasure of hearing this most important subject very ably discussed. It was agreed at that time (subject to certain reservations which are not important now), that all the evidence, proceedings and arguments which had taken place before Mr. Pope should be considered as re-taken before yourself, and should be used to the same extent as if you had heard them. This evidence, and the report of the arguments which had taken place before Mr. Pope, together with the arguments which we heard, and the briefs which were subsequently handed to us, contain the material on which I am now to give you my opinion.

* * * * * * * * * *

The application of the petitioners, rests on the set of facts following:—

The patentee has made his lamps out of glass bulbs and glass tubes made in the United States and imported from there into Canada; with platinum wires produced from platinum, mined in Russia, manufactured into wire in the United States and imported into Canada from there; with filaments of bamboo, grown in Japan, imported thence to the United States, carbonized partially in furnaces there, and imported thence into Canada, with brass bottoms made in the United States, to fit into lamp sockets, and imported into Canada; also with copper wire which has come from the United States.

The glass bulbs and tubes are the first articles to be considered. It is admitted that they are articles of commerce in the United States, in Canada, and in almost every other country, and were so for many years before the patent.

It is clear that bulbs and tubes of that description are used for other purposes than for electric lamps, the bulb being the simplest form the glass takes in the process of blowing, and the tubing being made and used for a great variety of purposes.

* * * * * * * * * *

A description of the patented lamp does not mention the glass bulb as being an essential part of the lamp. A transparent chamber of any shape, or of several parts joined, capable of affording a vacuum, would suffice. Therefore, the bulbs and tubes are not used exclusively for this purpose and are not even essential to the invention, strictly speaking.

These bulbs and tubes, as I have said, are not a part of the claim in the patent. In fact, it is quite possible to conceive of the patented article being made without them—made, for instance, in some other shape. However this may be, they are articles of commerce, which any one may import, manufacture, sell or use without infringing the patent. They were in use long before electric lamps were invented, are used for other kinds of electric lamps, and I cannot come to the conclusion that the importation of these into Canada incurred the forfeiture of the patent.

What I say on this point may be taken as said of many other articles which go into the composition of the lamp, and which will be referred to hereafter.

It does not seem reasonable that a person who has been placed expressly under the protection of the patent law, as a reward for inventive genius, and for expenditure of labor and capital in devising a patented article, should be subjected to enormous penalties for doing what everybody else may do, and I do not think that such would be a correct construction of the law.

It is clear, to my mind, that in respect of all these articles [glass bulbs, platinum and copper wires, etc.,] (and only one remains to be considered), every one of them is of the public domain, free to every person in Canada to manufacture, import, sell and use without thereby infringing the patent under consideration, and that, in respect of their use, the respondents incur no greater liability or penalty than they incur by importing, and not manufacturing, the plaster with which they seal the lamps, or any of the common appliances of the workshop which may be used in the manufacture.

The carbon filament remains to be considered.

This is described in the patent claim as "a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth," etc.

The strips of bamboo, out of which filaments are made, are imported from Japan, are split into threads in the United States, baked into a partly carbonized condition there, and sent from there into Canada. As a matter of fact, it seems that the carbonizing of the filament is a very difficult work, requiring great experience and skill. It has been principally done by Mr. Edison himself, and although perhaps, sometimes done by others has so often failed in the hands of others, even of those who had temporarily succeeded, that the work is practically reserved for Mr. Edison's factory in New Jersey, or was so at the time under consideration.

This was the case as to filaments for use in Europe as well as for use in Canada.

* * * * * * * * * *

After being brought into Canada it is attached to the leading wires and, during the process of exhausting the air from the glass bulb, is subjected to an electric current for the greater portion of half a day. The carbonizing which it receives in the United States and the treatment by electric current after it arrives in Canada, before the final completion of the lamp, are what make the filament a filament of high resistance and fully carbonized. It could hardly be said to be fully carbonized until the treatment which is given in Canada has been applied. * * *

I must observe of the filament, as of the other articles which I have enumerated, that the production or manufacture of this article is not covered by the patent claim or by the patent. True, it is a most essential part of the patented invention. It may, perhaps, be said to be what Mr. Pope declares it to be, "the novelty which the inventor has contributed to the art of incandescent lighting." To my mind, however, there is a mistake, which would lead to an erroneous conclusion on the whole subject, involved in the proposition which has been put before us in the following words:—"The carbon filament, as imported by the patentee and his representatives, the respondents, * * * is claimed in and covered by the patent; * * anyone who should use it, without the permission or consent of the respondents, would render himself liable to them in an action for infringement of the patent." Reading these words in connection with the statement that "the carbon filament of high resistance is the novelty which the inventor contributed to the art of incandescent lighting," one would expect, in turning to the patent, to find a patent simply for "a carbon of high resistance," because nothing but a novelty can be the subject of a patent, unless it be a new combination, and the language used in the proposition before quoted would not apply to a combination. But the carbon filament is not "the invention for which the patent is granted" (to quote the exact words of the enactment prohibiting importation, which is invoked here). On the contrary, the production of the filament is not covered by the patent at all. The "invention for which the patent is granted" is a *lamp* in which the filament is to emit the light. The lamp was old, the filament new. The combination was patented.

* * * * * * * * * *

If the making of a filament of carbon is not patented, but only the construction of a lamp with such a filament, the patentee is bound to manufacture his lamp, with the filament in it, in Canada; but he is not, I think, bound to manufacture his filament here.

* * * * * * * * * *

As I have already intimated, however, inasmuch as the making of the filament is not patented by this patent, I think that the filaments stand in the same position as all the other articles which go to form the lamp.

* * * * * * * * * *

If the parts were ready for use in the construction of the lamp—ready to be assembled, and merely requiring to be assembled in order to produce the patented invention, as seems to have been the case with regard to the Bell Telephone,—we should have to consider the question as to whether the invention for which the patent was granted was not really imported into the country, although imported in parts. We should then have to consider, with much doubt and difficulty, as I have already suggested, whether the penalty provided by the statute should not be attached to that offense to prevent an evasion of the law; but, in my view of the evidence, it is unnecessary to consider the case from that point of view, and it would be improper to decide it on any such principle.

* * * * * * * * * *

After reviewing some of the evidence as to the amount and kind of work done in Canada to produce lamps from the articles imported, the Minister says:—

This seems to show conclusively to my mind (1) that the invention for which the patent was granted was not imported, but was manufactured in Canada, and (2) that the invention for which the patent was granted was not imported *in parts.*

There remains to be considered the charge that the patented article was not manufactured in such a manner that any person who desired to use it could obtain it at a reasonable price. There is much evidence on this point. There is evidence that the respondents, at one time, refused to sell the lamps to persons who did not intend to use them with the Edison plant.

It seems that the Edison plant is simply a description of dynamo which Mr. Edison uses. It is not a machine of which he has the patent or any monopoly. The dynamos which are called the Edison plant can be purchased in Canada and in the United States. The explanation made in the evidence is that the electric lighting business was then in its initiatory stages, and that it was deemed by the Edison company most important that the success of the lamp should not be prejudiced in the public estimation by its being used in connection with plant which they believed it could not be used with successfully.

Under the charge of refusing to sell at a reasonable price, and as to the evidence of a refusal to sell, except for use on the Edison plant, the questions to be determined are:—

Is the evidence to be relied on which declares that this was the only limitation to the sale? and

Was the limitation made in good faith, in order to prevent the success of the lamp being destroyed and to prevent public opinion being prejudiced against it at a critical stage of the electric light business?

Was it reasonable?

Or, was the whole business carried on merely as a sham to avoid the forfeiture of the patent, while the company had no intention of really doing business in Canada?

* * * * * * * * * *

I am inclined to think that the evidence on this point in exoneration of the respondents from the imputation of bad faith, should be accepted. The burden of proof was on the petitioners to make good the charge of bad faith and of refusal to sell; and, in view of the explanations which some of their officers have made on this point, I see no good reason to doubt that the company were manufacturing lamps to sell, and intending to do so in good faith.

I think that the removal of their factory from Montreal to Hamilton, where greater facilities were expected and obtained, the enlargement of their business there, the contracts which the

MISCELLANEOUS.

In the suit of The Electrical Accumulator Co. *vs.* The Gibson Electric Co., in the United States Circuit Court for the Southern District of New York, which was instituted in February last, the complainants recently moved for a preliminary injunction, and Judge Lacombe on Friday, November 29, granted the motion, and the injunction issued. The complainant's testimony is to the effect that the Gibson company has continuously infringed the Faure patent, and that their various modifications are infringements.

At Troy, N. Y., a temporary injunction has been granted to the Hudson River Telephone Co. against the Watervliet Turnpike and Railway Co. The telephone company seeks to restrain the railroad company from operating its cars by the single-trolley electric system. A motion to make the injunction permanent will be argued at a special term.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From November 19 to December 10, 1889 (inclusive).

Alarms and Signals:—*Electric Police Signal System*, C. E. Scribner, 415,574. *Fire Alarm Telegraph Repeater*, F. A. Skelton, 415,578. *Fire Alarm Box*, G. L. Foote, 415,629, November 19. *Thermo-Electric Indicator*, F. W. Wiesebrock and E. Huber, 415,758. *Electrical Annunciator*, C. E. Lee, 415,915, November 26. *Gong or Tap Bell*, J. P. Tirrell, 416,243. *Electric Alarm*, R. D. O. Smith, 416,381. *Auxiliary Fire Alarm System*, T. Cooper, 416,444. *Auxiliary Fire Alarm* J. P. McMahon, 416,483. *Fire Alarm System*, J. Speicher, 416,513. *Electrical Signal Apparatus*, G. W. M. Conz, 416,572, December 3. *Electrical Annunciator*, F. S. Carter, 416,712. *Electric Door Alarm*, E. W. Taylor, 416,971. *Electric Indicator for Grain Bins*, A. C. Thompson and H. E. Newton, 417,117, December 10.

Clocks:—*Electrical Appliance for Winding Clocks*, F. A. Lane, 415,817. *Secondary Electric Clock*, E. L. Slocum, 416,148, November 26.

Conductors, Insulators and Conduits:—*Insulated Conductor*, J. A. Wetmore, 415,262. *Pole for Electric Wires*, L. R. Greene, 415,324 and 415,325. *Insulator for Electric Batteries*, C. Payen, 415,333. *Insulator*, G. Fowler, 415,504, November 19. *Joint for Coupling Underground Cables*, B. H. Wesslau and G. Trautwein, 415,751; B. H. Wesslau, 415,752. *Composition for Overhead Insulators*, S. H. Gilson, 415,864. *Insulating Hanger*, W. R. Park, 416,122. *Coupling for Underground Cables*, B. H. Wesslau, 416,143 and 416,144, November 26. *Distributing Box for Electrical Conduits*, E. S. Perot, 416,235 and 416,234. *Appliance for Insulating Electric Wires*, A. E. Ellinwood, 416,289, December 3. *Electric Conductor*, J. J. Saville and J. H. Winspear, 417,095, December 10.

Distribution:—*Electric Transformer*, E. Thomson, 415,749. *System of Electrical Distribution by Secondary Batteries*, S. C. C. Currie, 415,766, November 26. *Induction Coil Transformer, &c.*, E. Thomson, 416,762, December 10.

Dynamos and Motors:—*Dynamo-Electric Machine*, T. E. Daniels, 415,190. *Electric Motor*, H. B. Pullman, 415,350. *Armature Core for Dynamos and Motors*, F. F. Loomis, 415,363. *Governor for Electric Motors*, C. L. Jaeger, 415,641, November 19. *Armature Plate*, W. S. Belding, 415,695. *Coil Guard for Armatures*, same, 415,696. *Armature*, same, 415,697. *Lathe for Winding Armatures*, same, 415,805. *Armature for Electric Machines*, same, 415,806. *Dynamo-Electric Machine or Motor*, A. L. Riker, 416,013, November 26. *Regulator for Electric Motors*, N. S. Keith, 416,169. *Electro-Magnetic Motors*, N. Tesla, 416,191. *Method of Operating Electro-Magnetic Motors*, same, 416,192. *Electro-Magnetic Motor*, same, 416,193. *Electric Motor*, same, 416,194. *Electro-Magnetic Motor*, same, 416,195. *Magneto-Electric Machine*, W. H. Cooley, 416,443, December 3. *Commutator*, J. A. Dalzell, 416,720. *Coupling Electric Motors*, E. W. Rice, Jr., 416,746. *Compound Dynamo-Electric Machine*, F. B. Rae, 417,089, December 10.

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Telephones and Appliances:—*Telephone Exchange System*, C. E. Scribner, 415,573, November 19. *Telephone Receiver*, J. W. Bonta, 415,700. *Circuit for Multiple Switch-Boards*, J. J. Carty, 415,765, November 26. *Test-Circuit for Multiple Switch-Boards*, C. E. Scribner, 416,275. *Telephone*, E. H. Lyon, 416,476, December 3. *Telephone Switch*, J. Sack, 416,754. *Testing Apparatus for Multiple Switch-Boards*, C. E. Scribner, 416,808. *Test-Circuit for Multiple Switch-Boards*. same, 416,809. *Telephone Transmitter*, J. C. Eichmeyer, 417,009. *House Telephone Exchange*, W. M. Goodridge, 417,018, December 10.

EXPIRING PATENTS.

Patents relating to Electricity which become Public Property in January, 1890.

Reported for the Electrical Engineer, by F. B. Brock, *Patent Attorney*,
639 *F street, Washington, D. C.*

Fire Telegraph, F. Latta, 131,552, January 7, 1873. *Meter*, L. Bradley, 134,636, January, 7, 1873. *Duplex Telegraph*, J. B. Stearns, 134,776, January 14, 1873. *Printing Telegraph*, T. A. Edison, 134,866, January 14, 1873. *Automatic Telegraph*, T. A. Edison, 134,867, January 14, 1873. *Electro-Magnet*, T. A. Edison. 134,868, January 14, 1873. *Insulator*, N. Hendricks, 135,334, January 28, 1873.

[Drawings and specifications of any patent will be furnished by Mr. Brock at cost, 15 cents each.]

THE

ELECTRICAL ENGINEER.

Conducted by F. L. POPE AND G. M. PHELPS.

PUBLISHED MONTHLY AT

150 Broadway, New York City.

TERMS OF SUBSCRIPTION.

United States and Canada, - - - - - - per annum,	$3.00
Four or more Copies, in Clubs (each) - - - - "	2.50
Great Britain and other Foreign Countries within the Postal Union "	4.00
Single Copies, - - - - - - - - - -	.30

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. IX. NEW YORK, FEBRUARY, 1890. No. 98

NOT AN AFREET.

THERE can be no doubt that the fatalities caused by contact with electric light wires in New York during the closing months of last year, followed by the general destruction, as public nuisances, of arc lighting conductors on the part of the municipal authorities, have tended to create or to emphasize in the public mind a feeling of some terror in regard to all electric conductors, and a suspicion that electric lighting, particularly, is intrinsically a too dangerous public and private convenience; a suspicion that the confessedly mysterious force employed is in its nature erratic and intractable; that, unlike other forms of energy, its behavior under given conditions is uncertain; that it is incapable of complete regulation and direction. The daily press, with customary recklessness in times of public excitement, has, with little knowledge and much lurid rhetoric, done its utmost to intensify alarm and to darken counsel. Newspapers have been stimulated in their irrational and misleading treatment of the dangers of electric lighting through the rivalry of competing companies; who have not been slow in supplying the ready-writers of the press with "points" against the systems and methods of their adversaries. The public is told that high tension currents and alternating currents carry death, and that low tension currents carry fire, along with their light through our streets and houses; till it imagines itself "between the devil and the deep sea," with no safety anywhere.

In the haste and tumult of the daily press—with a few conspicuous exceptions—discrimination and wisdom in the treatment of the topics of the day is no longer looked for; but those qualities are expected in the more deliberate utterances of men qualified by character and experience to lead or guide public opinion through their less frequent periodical writings.

From his "Easy Chair," which he has graced for so many years, and whence so many lovers of wisdom, moderation, wit and fancy have gratefully received a monthly allowance for half their lives, Mr. George William Curtis indites, and prints in *Harper's* for February, the following:—

> Our Uncle Sam plumes himself greatly upon his latest achievement—the electric light. But how many a hapless victim has been put to sudden death by the wretched wires in the streets of New York alone! The Boston fire was caused by these uncomprehended agents, and it is shrewdly suspected that the Brooklyn Tabernacle was kindled by them, and not, as was wildly suggested, by the fervor of the pastor's eloquence.
>
> The truth is that the electric light is an untamed afreet. Its laws are apparently ill understood. The courteous host who shows you through his noble mansion, *illuminato al giorno*, is evidently a little afraid of his nimble servitor. Candles and gas and the lamp of sperm or kerosene are familiars in the strictest sense. He anticipates no ill-turn from them save the malodorous consequence of neglect properly to shut off the gas. But the latest light-bearer seems to him uncanny and lawless, and nobody is qualified to instruct him how to control or subdue its antics. The law requires the wires to be buried in the city, and the newspapers peremptorily demand the execution of the law. But the chief of experts in the use of lightning, who is presumed to know all because the rest presumably know nothing, remarks that the wires of telephones and telegraphs and electric lights and the pipes of gas and steam will not make a subterranean happy family, but at any moment they may be mutually exasperated to a degree of fury which will hurl even the Equitable skyward. If the electric wires burn up Boston they will probably blow up New York, remarks the musing philosopher who precedes the New-Zealander upon the Brooklyn Bridge. But if you ask him what we shall do, he shrugs his unanswering shoulders.
>
> Last summer passed in a debate whether the recommendation of an accomplished commission, enacted into law by a presumably competent legislature, ordaining capital execution by electricity, must not be set aside as practically useless for its purpose. Yet if the ordinary wire chances to kill the innocent so readily, why should not the carefully directed force be fatal to the guilty? Counsel argued and judges pondered and the public wondered. The doubt of the new agent revealed again the perilous imperfection of our knowledge of the force which we have newly constrained to our service.

The wit and fancy of the "Easy Chair" are here in abundance; but where are the discrimination and the moderation? Has he not let his facile pen play with a subject which he has not taken pains to look into carefully? Ought he not to have learned that the electric light is *not* an "untamed afreet"; that the laws of electricity are *not* "ill understood," but well understood; that, like water and steam, its current and its pressure can be accurately measured; that its effects under given conditions can be accurately predicted and limited; and that it has caused destruction to life and property through the neglect of perfectly well-known precautions and safeguards; just as people are burned alive in railroad cars heated by stoves? Mr. Curtis's allusion to "candles and gas and the lamp of sperm or kerosene" is singularly infelicitous: they are indeed "familiars in the strictest sense"; familiar not less through their thousands of hapless victims than through the "malodorous consequences of neglect."

Mr. Curtis makes a point of the uncertainty of opinion among electricians, brought out in the Kemmler investigation last summer, in respect to the deadly effects of electricity, as "revealing the perilous imperfection of our knowledge of the force which we have newly constrained to our service." Every one knows that enough electricity will kill a man. We know that a fall from a sufficient height will kill a man. But because we are unable to say with certainty that a fall from the second or the third story of a house will kill a given person—although it usually suffices—do we reveal a perilous imperfection in our knowledge of gravitation?

Now the truth is that the "latest light-bearer" is no more "uncanny" or "lawless" than steam. Steam will rend any inadequate boundaries; so will electricity. Each, in sufficient quantity and under sufficient pressure, when let loose, carries death and destruction in its path. In both cases there is no doubt whatever in respect to the adequacy of well-known means of regulation and control. People are killed and property is destroyed, not because electricity is unmanageable; but because the average American takes too many chances, is more anxious to reach his point by the quickest and cheapest route than by the safest and best. Hence the notoriously defective and dangerous character of much of the electric light construction of the past. Let Mr. Curtis and other leaders of public opinion do their utmost to stigmatize cheap and adventurous electrical engineering, and to train the community to submit to no needless dangers, whether from electric lights, steam boilers, railways, or other instruments of civilization and progress, and they will accomplish far more towards securing better conditions of safety and convenience than can be achieved through ill-considered and sweeping statements on technical subjects.

No better testimony to the superiority of electricity to all other illuminants in the matter of fire risk is needed than the experience of the Boston Manufacturers' Mutual Insurance Co. In a circular recently issued by its president, Mr. Edward Atkinson, it appears that from 61 mills equipped with electric lights anterior to April 1, 1882, there had been received, up to that date, reports of 23 fires caused by the electric current. A careful investigation, made under the direction of Mr. C. J. H. Woodbury, resulted in the adoption of rules for construction and insulation, guarding against the dangers disclosed in the 23 fires reported. The rules were enforced in all risks assumed by the insurance company, and remain unchanged to this day, except in so far as additions to them have been made to meet the requirements of new forms of apparatus.

Mr. Atkinson is now able to report that since April 1, 1882, his company has received no notice of any fire that could be attributed to electricity in the case of any risk insured by his company. Electricity is now employed for lighting or motive power in more than 600 risks insured by the Factory Mutual Companies.

"Our experience, therefore," says Mr. Atkinson, "justifies the conclusion to which we came after the first two years of electric lighting, that, under proper safeguards, it is the safest method of lighting that can be introduced."

THE Special Committee appointed by the National Electric Light Association, at the convention of last August to memorialize the proper committee of Congress for the abolition of customs duties on copper, presented their petition to the Ways and Means Committee of the House of Representatives, January 16, together with a brief statement of reasons, which we print on another page. The committee are circulating printed copies of an auxiliary petition, to which they desire to obtain the signatures of companies, firms or individuals engaged in electrical or other industries in which copper is consumed. Any who have not received a copy, and who wish to sign, will oblige the committee by addressing either of its members, viz.:—C. A. Brown, 227 South Clinton street, Chicago; G. M. Phelps, 150 Broadway, New York; J. F. Morrison, 15 South street, Baltimore.

The mood of the present Congress cannot be considered very favorable to tariff revision or to reform of any kind. But whatever the chances for the abolition of duty on copper, we have yet to hear a word in favor of retaining it on its merits. The only reason we have heard assigned for letting it alone comes from certain manufacturers who consume large quantities of copper, and who frankly say they would be glad to see the duty go; but they or their friends or business associates, are interested in keeping up protective duties on other things, and they dread a general stirring up of the tariff.

THE situation of the electric lighting companies in New York has not materially changed during the past few weeks; arc lighting is practically at a stand-still; and an evening stroll through some of the principal streets and squares, with their blinking gas jets, is suggestive of by-gone days come again. Everybody is heartily tired of the Board of Electrical Control and all its works, and waiting for better days. Bumptious and bellicose Mr. Gibbens has left the board;—to meditate what fresh designs in the quiet of his tent?

We shall probably find a new scheme for some sort of electrical control for the city or state enacted before the year rolls around; but it will be no better than the present plan unless politicians are driven out and kept out.

WE print in this issue the second and concluding portion of Mr. Wm. L. Puffer's very interesting and suggestive "Data of Various Incandescent Lamps together with an Improved Method of Testing." The tables and plots bring out many points of importance; not the least of which is the desirability of some generally accepted understanding as to what precisely shall be meant by a 16 c. p. lamp.

In our March number a supplementary paper will be published, entitled "The Distribution of Light Around Incandescent Lamps, with Efficiency Tests," by Henry Hobart and Earl Gannett, with plots and additional tables by Mr. Puffer.

THE Electric Light Convention, to be held at Kansas City February 11–14, has work enough cut out for it to fill four days laboriously but profitably. It is understood that the programme, as printed in our January issue, will be carried out in full.

PERHAPS no electrician of continental Europe is better known to American electricians than Herr F. von Hefner-Alteneck, who for twenty-three years has been in the employ of the firm of Siemens & Halske in Berlin. It is a matter of some significance that after so long a connection with the greatest electrical house in Europe Herr von Hefner-Alteneck should leave them to cast his lot with whom?—in Munich.

ARTICLES.

A REVIEW OF MODERN ELECTRICAL THEORIES.[1]

BY PROFESSOR WM. A. ANTHONY.

The general phenomena of electricity are familiar to us all. As children we learned of the attraction and repulsion of electrostatic charges, of condensers, of insulators and conductors, of electric currents and electro-magnets, of telegraphs, electric fire alarms and electric bells, of the heating of conductors, and even of electric lights. We have long been familiar with the effect of the current on a magnetic needle, and with the attraction and repulsion of currents for each other. We have seen that these effects are manifested at a distance from the conductors which carry the currents, and we have been willing to believe that the distances at which these phenomena could be recognized were limited only by the want of sensitiveness of the apparatus through which the effects were manifested. Probably not many of us stop to think *how* these effects were brought about. We were content with a general statement of the relations of the phenomena, or, at least, with the determination of the direction and intensity of the forces due to a given conformation of current. We talked of the attractions and repulsions as action across space, and, if we thought of them at all as requiring any mechanism through which to act, we still felt satisfied when we had discovered and formulated the laws that govern the action of these forces.

It did not matter to us that attraction across empty space was unthinkable; it was enough that action took place, and that we could measure and, to a certain extent, control it. We constructed instruments and computed forces acting under certain conditions; we multiplied experiments and thought we had developed a vast science. But there have not been wanting, even among the earlier philosophers, some who could not feel satisfied with the idea of action at a distance. Experience gives no clue to any explanation of action of one body upon another at a distance, except through some intervening mechanism, and if we find cases where such intervening mechanism is not apparent, to say that in these cases action at a distance is taking place, is only to say that the action is unexplained.

Gravity acts upon the distant planets, and, we believe, upon the most distant stars; but it is not enough to say that gravity acts, that it decreases as the square of the distance increases, we want to know *how* it acts. By what means or through what medium does our earth reach out to the distant planets and affect their movements? These are the questions that the dissatisfied few have asked in the past, and to-day it is not the few but the many who would be glad to have the question answered. Faraday early taught us that the mere statement of the law of electrical attraction or repulsion was no explanation, and he sought the explanation in the action in the intervening medium. He demonstrated by experiments that have become classic, that the effect of induction depends upon the nature of the medium intervening between the conductors; a demonstration that here, at least, the intervening medium took part in the action and helped to determine the result. Magnetic and electro-magnetic phenomena were to Faraday also effects propagated through the medium; and Maxwell, following Faraday's work, subjected the whole matter to a searching mathematical analysis. It was necessary, in order to complete the theory, to assume the existence of a medium in which the forces were exerted; but, as a medium had already been assumed to account for the phenomena of light, it would hardly be scientific to assume another to account for electrical phenomena. But would not one medium suffice for electrical and optical phenomena as well? Maxwell showed how the question of the identity of the two media could be tested, and our modern views of electricity are mainly the results of his work. What do we *know* of electrical phenomena? We know that pieces of glass and silk rubbed together and then separated attract each other; that the property of attraction can be imparted to metals if they are insulated; that if two such masses of metal be connected by a wire the power of attracting each other disappears, and, at the same time, the wire is warmed and for an instant exerts magnetic forces at right angles with the wire. Numerous other facts we know, but these will suffice as illustrations of the phenomena. When a metal conductor is discharged by touching it with a wire we say the wire carries a current, and we have been accustomed to ascribe the heating and the magnetic effects to that current. We have looked upon the thing, whatever it is, that takes place in the wire as the origin of all that takes place around it. The current warms the wire, and it confers upon it the property of acting upon magnetic needles; but *how* does it act? We cannot conceive of the action of that wire on that needle, except through something extending from the wire to the needle through which the wire can exert a push or pull. All around that wire the needle is affected; at considerable distances the effect can be exhibited, and we believe it is only want of delicacy of our apparatus that prevents our discovering it at the greatest distances. If the wire acts it acts through a medium in which it creates a disturbance, and the disturbance in turn acts upon the magnetic needle. But are we sure that the action begins with the wire? Is it not possible that the action begins in the medium, and that the wire merely separates portions of the medium and so permits action that could not otherwise take place? Maxwell has proposed a mechanical illustration of the action taking place in space when electrical phenomena occur, and Fleming and Lodge have elaborated it and brought it within the reach of non-mathematical readers. Let us suppose all space to be filled with wheels connected by idle wheels in such a way that when one turns all must turn in the same direction, except that the elasticity of the system permits a small movement of one wheel before the others in the vicinity begin to move. Electromotive force is then something that tends to turn the wheels. Let *b* in figure 1, represent some source of electromotive force; *a* and *c* conductors, not forming a closed circuit but having an opening at *d*. The electromotive force at *b* tends to turn the wheels, but so long as the gap exists at *d* the wheels are connected through all space, and the E. M. F. at *b* can effect nothing except to turn the wheels through a small angle until the elastic resistance balances the E. M. F. In the conductor the wheels are not supposed to be rigidly connected. They can turn by slipping on each other, and the wheels in space may turn by slipping on the wheels in the conductor; hence, as the ends of *a* and *c* approach each other, the connection between the wheels within the enclosure and those of outside space becomes smaller and smaller, and, when the conductors touch, there is no longer anything to prevent the wheels within from turning, and they begin to spin in obedience to the E. M. F. at

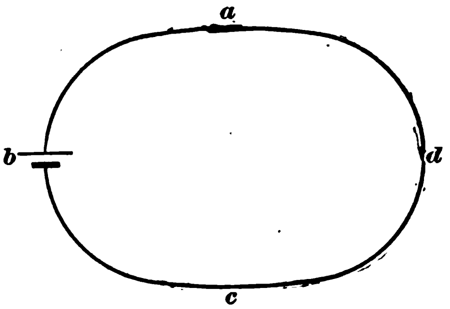

FIG. 1.

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[1] Read before the American Institute of Electrical Engineers, New York, January 21, 1890.

b. The conductor is heated by the friction due to the slip of the wheels around and within it. The spinning of the wheels constitutes the magnetic forces if we assume the wheels, originally spherical, to become flattened spheroids by the spinning, and to be forced to remain in contact at their poles. Assume the wheels to have inertia, and it will require time for them to reach their full velocity, and the time will be greater as the number of wheels is greater, that is, as the magnetic forces developed are greater. On the other hand, the wheels will not at once stop if the electromotive force is removed, and if the conductor be broken at some point, allowing the rapidly spinning wheels enclosed by it to come in gear at that point with the stationary outside wheels, there will be, for a brief time, until the moving wheels can be brought to rest, a clashing and disruptive action known as the extra spark.

I have spoken of the heating of the conductor as due simply to the friction of the spinning wheels upon the wheels within the conductor. The greater the friction the greater the motion imparted to the wheels within the conductors and the greater the heating. The less the friction the less the heat, and if there were a substance whose wheels could revolve among themselves and against the wheels of space without friction, such substance would form a perfect conductor which would offer no resistance to the motion of the wheels in the space enclosed by it, and however rapidly those wheels might revolve they would have no influence to produce motion within such a conductor. We are led, then, to this, that a perfect conductor, instead of being a substance in which any E. M. F. produces an infinite flow of electricity, may be a substance in which no effect whatever is produced.

I do not present this as representing the real activities involved in electrical phenomena, or as a theory by which all electrical phenomena may be explained. I give it as bringing prominently into view the activities in the medium surrounding the conductor; whereas, the language in which we usually describe electrical phenomena points to the conductor itself as the seat of the electrical forces. Whatever our theory, we know that something does take place in the medium that surrounds the conductor. We know that were a heavy current to flow through a conductor in the most distant part of this room a delicate needle here on the table would show that a magnetic field was produced here. We are certain that magnetic lines of force from the electric currents on our streets, whether overhead or underground, permeate this room, and traverse our bodies, even though we have no sense through which we can become directly conscious of them. Take in your hands two wires connected to the poles of a battery or dynamo and touch their ends together. You see a flash of light, the wires become warm, they attract iron filings; coiled into a spiral they will attract with great force large masses of iron; two such spirals will attract or repel one another. What more natural than to say, Here in the wire is a new activity which warms it and confers upon it magnetic properties? What more natural than to forget or fail altogether to recognize the activities in the space around; activities that do not impress any of our senses; that do not wrench our arms, or burn our flesh, or blind our eyes; and yet it is well to fix our attention for a while upon the space that the conductor encloses, and recognize the fact which the little delicate needle demonstrates to us, that something is going on in that space, something quite as important, perhaps more important, than that which takes place in the conductor.

Whatever the magnetic forces are, we know they cannot be called into existence instantaneously. Time must always elapse before the full effect of an electric current is felt, and the greater the forces developed the longer are they in reaching the maximum. Moreover, the current in the wire cannot be developed at once; it keeps pace with the magnetic force and reaches a maximum only when the magnetic forces reach a maximum. This is exactly what would follow if magnetic forces result from the setting in motion of wheels possessing inertia. Whatever magnetic forces may be, they begin and end like the motions of massive bodies.

Continuing our hypothesis, an electromotive force would be anything that tends to set the wheels in motion. The wheels are set in motion if a limited number acted upon by the E. M. F. are separated by a conductor from the other wheels of space; but, even if they are not separated, that is, if the conductor does not form a closed circuit, the wheels are rotated through a small angle, depending on the elasticity of the wheel work. This displacement constitutes an electric charge, the tendency of the wheel work to spring back is *difference of potential*, and this difference of potential is maintained by the E. M. F. Here allow me to call attention to the distinction between difference of potential and E. M. F. I often see statements that indicate that the distinction is not clearly kept in view. In that excellent little volume, the Dictionary of Electrical Terms, the statement occurs that electromotive force is *due to* difference of potential. It should rather be difference of potential is due to E. M. F. Difference of potential is *an* electromotive force, but not all electromotive forces are difference of potential; and, furthermore, I can think of no case of difference of potential that does not owe its existence to some other electromotive force *not* difference of potential. Difference of potential is a moving force acting from within. Electromotive force acts from without. Difference of potential results from a changed electrical distribution, an electric strain, and represents the tendency to return to the state of equilibrium. Electromotive force is the something from without that produced the electric strain. Consider our wheelwork illustration. I may seize a wheel here and turn it, but I can only turn it through a small angle before the elastic forces, brought into play by the distortion, balance the force that I am able to exert. My force is electromotive force, the elastic forces are difference of potential. Let figure 2 represent a voltaic cell with its copper and zinc plates and dilute acid; we know that something takes place by which the copper becomes positive and the zinc negative, and, if the copper and zinc be joined by a wire, electricity is said to flow from the copper to the zinc through the wire, and from zinc to copper through the liquid. The flow through the liquid used to be explained by assuming the zinc to be positive and the copper negative within the liquid; just the reverse of what we find without. But connect the copper to the zinc by a wire within the liquid: the current flows through the wire from the copper to the zinc. The copper, therefore, is not negative, but everywhere positive. Then why does the current set from the zinc to the copper through the liquid? Because there is an electromotive force, not difference of potential, mind you, for the difference of potential tends to cause a flow the other way, but a something that forces the current through the liquid against the electric pressure. The cell is an electric pump that pumps electricity from the zinc into the copper until the pressure becomes so great that the pump stops. Open a passage from the copper to the zinc by connecting the two by means of a metallic wire, the electricity flows and relieves the pressure, the pump begins to work and so maintains a continuous flow. No; E. M. F. is not difference of potential, although difference of potential is E. M. F. It is even possible to produce an electric current without any difference of potential whatever in any part of the circuit, just as it is possible to produce a flow of fluid without any difference of pressure.

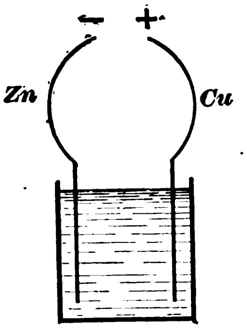

FIG. 2.

Whatever difference of potential may be, it behaves like a force developed by an elastic displacement in a solid body. Whatever magnetic forces may be, they behave as though produced by the motions of inert masses. An electromotive force, suddenly brought to bear at a given point, has to overcome not only the elastic force but the magnetic inertia. In other words, an electromotive force, tending to produce current, immediately develops a difference of potential against which it must act, and also develops magnetic forces which retard its action; so a *fluid-moving force* meets opposition in the elastic force of the fluid and in the inertia of its particles. But the effect of any such force is propagated through the medium with a finite velocity expressed by the well-known formula,

$$V = \sqrt{\frac{E}{D}}.$$

Electric displacements ought, therefore, to be propagated with a finite velocity which should have some relation to the ratio between the electrostatic effects, analogous to elastic displacements, and the electro-magnetic effects, analogous to the effects of moving masses. You all know that it is shown that this velocity is expressed by the ratio of the magnitudes of the electro-magnetic and electrostatic units quantity, and you know also that determinations of this ratio show it to be the velocity of light. This determination gave a very strong support to Maxwell's electro-magnetic theory of light, and, coupled with the fact that observations, so far as they went, indicated that magnetic effects are propagated from the sun to the earth with the same velocity as light, made the theory at least extremely plausible. But within two years the wonderful experiments of Hertz have demonstrated beyond question that electro-magnetic waves travel through space from every source of alternating currents or potentials, and that the waves travel with the velocity of light. In this city there are, I suppose, many alternating current systems. When we think of these in action we are apt to think only of the activity in the conductors of the machines, the lines, the transformers, the lamps, and yet we know that in all the space around there is activity. Waves are chasing each other through this room, through our streets, our houses, our offices. They are everywhere present. We are bathed in this agitated medium every moment, and yet we live, and not only live, but are totally unconscious of the activity that surrounds us. No sense responds to the wave motion that fills this space. And yet, when these waves become short enough and frequent enough, they do affect our sense of vision and a vast array of phenomena that otherwise would have had no existence for us, are made known to us through this special sense. But the eye only responds to waves of $\frac{1}{70000}$ to $\frac{1}{37000}$ of an inch in length, while the length of the waves emitted by one of our alternating current systems is 600 miles. The waves that affect the eye must occur at the inconceivable rate of at least 400 millions of millions per second, while less than 300 waves per second are emitted from our alternating systems. These waves come very far short of the number necessary to effect any of our senses; but we have been able to demonstrate their existence; at least we have been able to show that something possessing all the characteristics of wave motion exists in the space around a source of alternating currents or potentials. It is something to know that waves of such enormously different lengths and frequencies exist in the medium that is agitated by waves of light. It is something to understand that our sources of alternating currents are centres of radiant energy, differing from light only in wave length; and since we have begun to appreciate this fact, we have often asked ourselves the question: Can the rate of alternation be increased until the whole apparatus should glow with light? Although the enormous rapidity required seems to render this direct solution impossible, it seems to me there must be a way to obtain the light we want without all this waste of energy. I cannot believe it will always be necessary to develop waves of all lengths, from many miles down to a hundred thousandth of an inch, in order to obtain the narrow range of wave lengths by which we see. I do not know of any practical way of obtaining the few wave lengths that constitute light without at the same time producing the others, but it *is* done. The glow-worms do it, the fire-flies do it, the lantern beetles do it, and I believe the time is coming when man can do it. Instead of getting 10 16-candle lamps per horse-power we ought to get 200. I don't know how it is to be done. I don't expect we are going to make alternating machines to produce 500 millions of millions of alternations per second. But possibly we may solve the problem indirectly by the use of some substance having a special rate of vibration, such as the gases. Possibly we may be able to excite electrically the fluorescent salts. Possibly we may be able to charge and discharge a condenser and take advantage of the oscillatory discharge to set up vibrations of the frequency required. Possibly we may discover the secret of the glow-worm and fire-fly and substitute electric for the insect energy. I know it will take several fire-flies to equal a 16-candle lamp, but it will also take a good many fire-flies to develop a horse-power. But although I do not see at present any practical solution of the problem, I repeat, I believe the problem can and will be solved. We are not going on forever burning a coal mine whenever we want a little light. Neither are we going on forever converting the energy of coal into heat when it is mechanical or electrical energy we want. From the very nature of things not more than one-fourth or one-third the heat so produced can be transformed into any other form of energy. The energy of fuel *can* be converted into mechanical energy without first becoming heat. It *is* so converted in every animal movement. The way exists; let us find it. Find this, and the way to make light only when it is only light we want, and we shall have lengthened the life of our coal deposits five or ten times. The man who solves either one of these problems will be the greatest discoverer of this or any other age. If he gets a broad patent on it, he will have seventeen years of the grandest litigation the world ever saw.

Now I can imagine that some electrician will consider that the first part of this paper dealt with matters that are of no practical consequence in the use of electric currents. Of what practical consequence is it whether force is conveyed to a distance by means of a medium or simply acts at a distance. What does it matter whether electric energy is conveyed by the conductor or through the dielectric? We know how to proportion and dispose our conductors to produce a given effect, and that is enough. But consider what we have learned already of the intimate connection between light and electricity, and I think you will agree that the more we know of the ultimate nature of electricity the nearer we shall be to the solution of the great problem to which I have referred, and the solution of either one of those problems would revolutionize some of the most important industries of the world. May not the solution of at least one of these problems be accomplished and the results exhibited at the great exhibition to be held in New York in 1892? What a wonderful achievement it would be to light all those great buildings without waste, heat, or drive all that vast array of machinery without a fire!

.... AT present the best dynamos are made by experienced mechanical engineers who have somehow picked up a working knowledge of electricity.—*John Perry.*

.... IN the earlier days of railways and telegraphs, not only had altogether new edifices to be erected, but the material out of which they have been constructed had to be searched for and discovered.—*S. Alfred Varley.*

.... IF the plant is to be run on proper principles of economy not a fire should be built, not a day's run made, without a perfect record being kept of the weight of every shovel of coal and every ounce of refuse left from the burning.—*C. C. Haskins.*

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS TOGETHER WITH AN IMPROVED METHOD OF TESTING.[1]

BY. WM. L. PUFFER.

(Concluded from page 6.)

1887–8 *lamps in order of efficiencies expressed in terms of watts per horizontal candle-power.*

Lamp.	Voltage.	Rated c. p.	Watts per c. p.	Can les per e. h. p.
1. Swan.	46	16	3.06	244
2. Thomson-Houston.	52.6	20	3.18	235
3. " "	75	16	3.27	228
4. Swan.	92	32	3.44	217
5. "	36	8	3.64	205
6. "	46	8	3.67	203
7. Edison.	101	32	3.82	195
8. Swan.	92	16	3.90	190
9. Thomson-Houston.	110	16	4.04	185
10. Swan.	38	16	4.05	184
11. Swan.	92	10	4.21	177
12. Weston.	110	16	4.36	171
13. "	70	16	4.72	158
14. Edison.	101	16	4.84	154
15. "	101	10	4.98	150

1887–8 *lamps in order of efficiencies expressed in terms of watts per spherical candle-power.*

Lamp.	Voltage.	Rated c. p.	Watts per sph. c. p.	Candles per h. p.
1. Swan.	46	16	3.56	209
2. Thomson-Houston.	52.6	20	3.91	191
3. " "	75	16	3.97	188
4. Swan.	92	32	4.03	185
5. "	46	8	4.17	179
6. "	36	8	4.27	175
7. Edison.	101	32	4.57	163
8. Swan.	38	16	4.70	159
9. "	92	16	4.76	157
10. Thomson-Houston.	110	16	4.95	151
11. Weston.	70	16	5.01	149
12. Swan.	92	10	5.30	141
13. Weston.	110	16	5.32	140
14. Edison.	101	16	6.00	124
15. "	101	10	6.26	119

1887–8 *lamps showing candle-power actually given out on the horizontal circle in percentage of the rated candle-power.*

Lamp.	Voltage.	Rated c. p.	%
1. Edison.	101	32	107
2. Swan.	46	16	105
3. Edison.	101	10	104
4. { Thomson-Houston.	52.6	20	103
5. { Edison.	101	16	103
6. Swan.	92	32	102
7. Thomson-Houston.	75	16	101
8. Swan.	36	8	97
9. Weston.	70	16	94.6
10. Swan.	92	10	90.3
11. "	92	16	87.5
12. Weston.	110	16	86.3
13. Swan.	46	8	83.8
14. Thomson-Houston.	110	16	80.4
15. Swan.	38	16	76.6

1887 *lamps. Table showing candle-power actually given out in spherical candle-power in percentage of rated candle-power.*

Lamp.	Voltage.	Rated c. p.	%
1. Swan.	46	16	89.9
2. Edison.	101	32	89.4
3. Weston.	70	16	89.1
4. Swan.	92	32	86.7
5. Thomson-Houston.	52.6	20	84.0
6. " "	75	16	83.2
7. Edison.	101	16	82.9
8. Swan.	36	8	82.6
9. Edison.	101	10	82.5
10. Swan.	46	8	73.6
11. "	92	16	71.8
12. "	92	10	71.7
13. Weston.	110	16	68.5
14. Swan.	38	16	66.1
15. Thomson-Houston.	110	16	65.6

Comparison of last four tables, showing position of lamps when compared according to the methods.

Lamp.	Voltage.	Rated c. p.	Watts per sph. c. p.	Watts per hor. c. p.	% sph. c. p.	% hor. c. p.
Swan.	46	16	1	1	1	2
Thomson-Houston.	52.6	20	2	2	5	4
" "	75	16	3	3	6	7
Swan.	92	32	4	4	4	6
"	46	8	5	6	10	12
"	36	8	6	5	8	8
Edison.	101	32	7	7	2	1
Swan.	38	16	8	10	14	15
"	92	16	9	8	11	11
Thomson-Houston.	110	16	10	9	15	14
Weston.	70	16	11	13	3	9
Swan.	92	10	12	11	12	10
Weston.	110	16	13	12	13	13
Edison.	101	16	14	14	7	5
"	101	10	15	9	9	3

A study of these tables and plots will make it very evident that there is no commonly accepted value of a candle-power, or, if there is, that different makers vary widely in their attempt to produce it. The question, "What is meant by a 16 c. p. incandescent lamp?" has not, I believe, been settled by the courts, and until it is, there will be endless dispute as to whether a given lamp is "up to candle-power or not."

For example, take the Edison 101-volt 16 c. p. lamp; if we rate it by the light given off "on the face of the loop," *i. e.*, the standard reading, it is evidently 13.00 c. p., but if we select a point 45° from this it is about 19.00 c. p.; if we try to do better and take the mean horizontal candle-power then it is 16.46 c. p., or if we wish to take the mean spherical candle-power we find it to be 13.25 c. p. The watts in all cases being 79.58 we can sell this lamp as either 7.71, 4.09, 4.84, or 6.00 watts per candle.

It is, I think, commonly understood that the lamps of the Edison company are rated according to the following definition of a 16 c. p. lamp. A new 16 c. p. lamp will, when run at the number of legal volts indicated by the number on its base, give out light which, at a point on the horizontal circle 45° from the shanks, will be equal to 16 standard candles. This one point is taken to represent the mean horizontal candle-power. It will be noticed that the Edison lamps tested come fairly close to this rating, and also that the other lamps do not, indicating that the other makers do not understand a 16 c. p. lamp to be the same thing that the Edison company do.

It would be a great advantage to all parties if some authoritative statement of what is meant by the candle-power of an incandescent lamp could be made, and thus settle at once the uncertainty now existing.

ROGERS LABORATORY OF PHYSICS,
Mass. Inst. of Technology, Dec., 1889.

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[1] Plots are given for nine of the 15 lamps tested and tabulated [see ELECTRICAL ENGINEER, January, 1890]. The remaining six were not plotted.

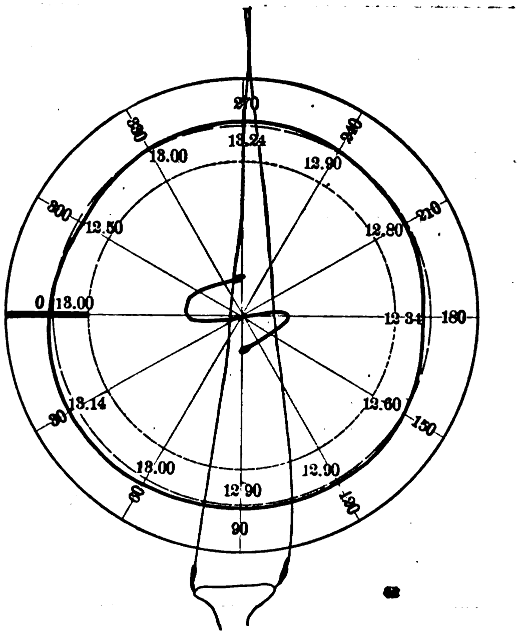
Data and Plots of Various Incandescent Lamps.—Plate V.

Lamp.—Thomson-Houston, 110 volt. 16 c. p.
Mean standard reading = 13.00.
Mean spherical c. p. = 10.50.
Spherical reduction factor = 0.808.
Mean horizontal c. p. = 12.86.
Horizontal reduction factor = 0.990.
Mean sph. c. p. + Mean hor. c p. = 0.816.
Volts = 110.1.
Amperes = 0.472.
Watts = 51.96.
Watts per mean sph. c. p. = 4.95.
Watts per mean hor. c. p. = 4.04.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament. = ●
Scale, 10 c. p. per inch.

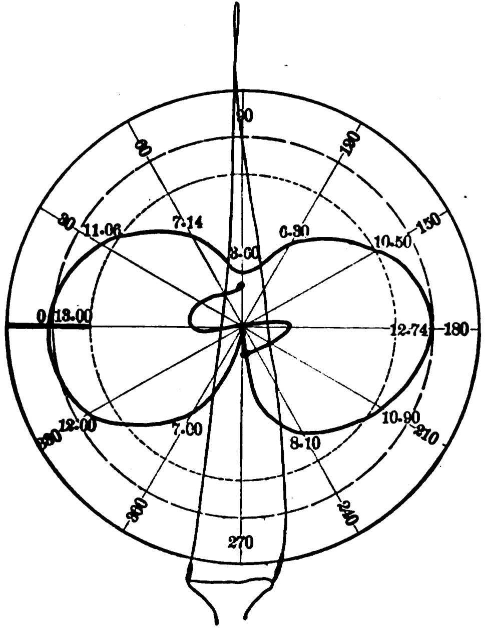
W. L. P.

Full circle reduced from 3.2" to 2.5" in engraving.

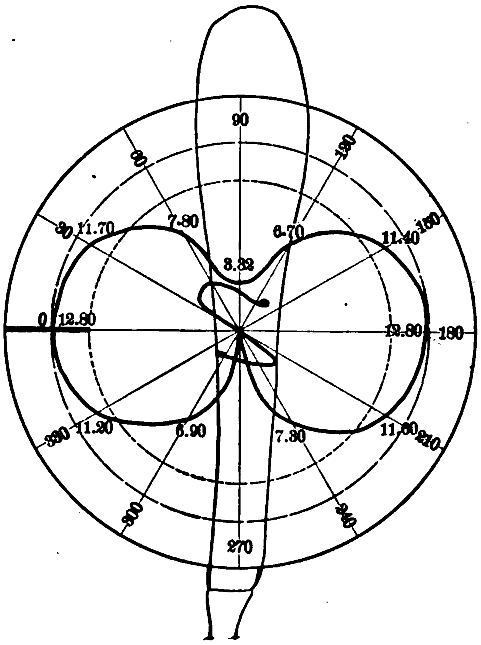
HORIZONTAL



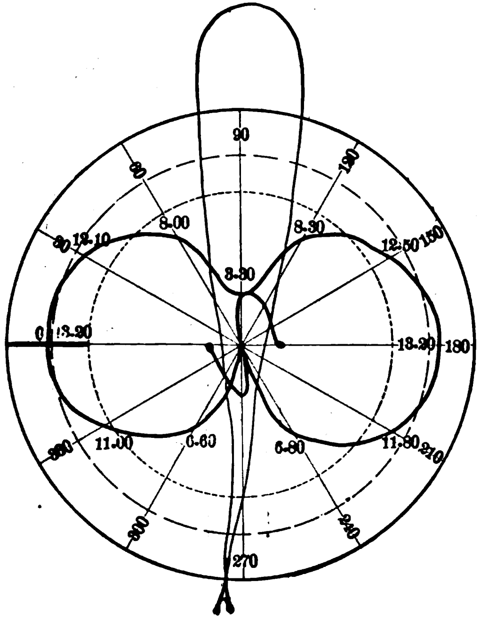
VERTICAL 0°



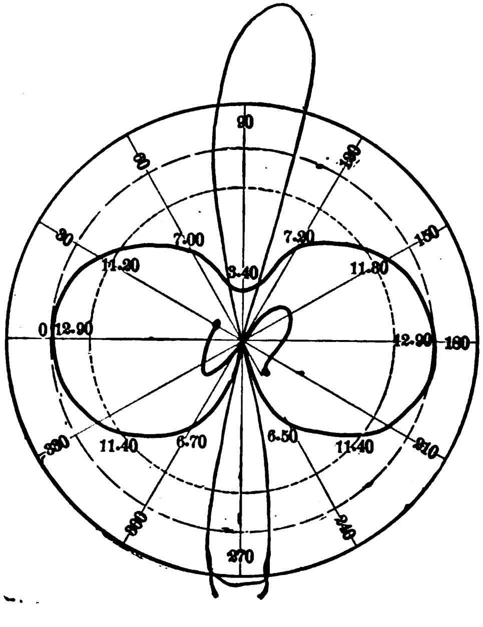
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°



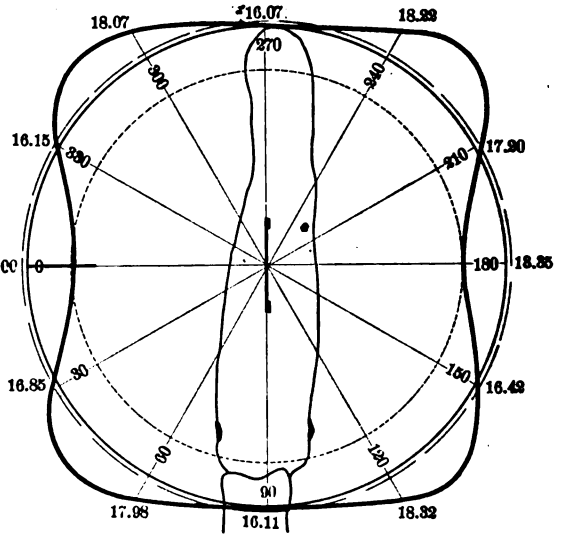
DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE VI.

Lamp.—Edison, 101 volt. 16 c. p.
Mean standard reading = 13.00.
Mean spherical c. p. = 13.25.
Spherical reduction factor = 1.02.
Mean horizontal c. p. = 16.46.
Horizontal reduction factor = 1.27.
Mean sph. c. p. ÷ mean hor. c. p. = 0.805.
Volts = 100.9.
Amperes = 0.789.
Watts = 79.58.
Watts per mean sph. c. p. = 6.00.
Watts per mean hor. c. p. = 4.84.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = ■
Scale, 10 c. p. per inch.

W. L. P.

Full circle reduced from 3.2″ to 2.5″ in engraving.

HORIZONTAL



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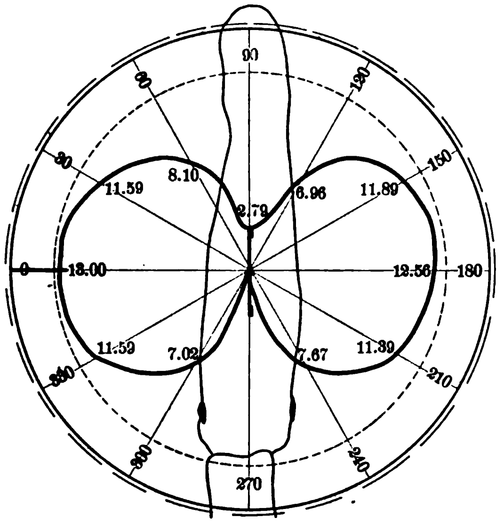

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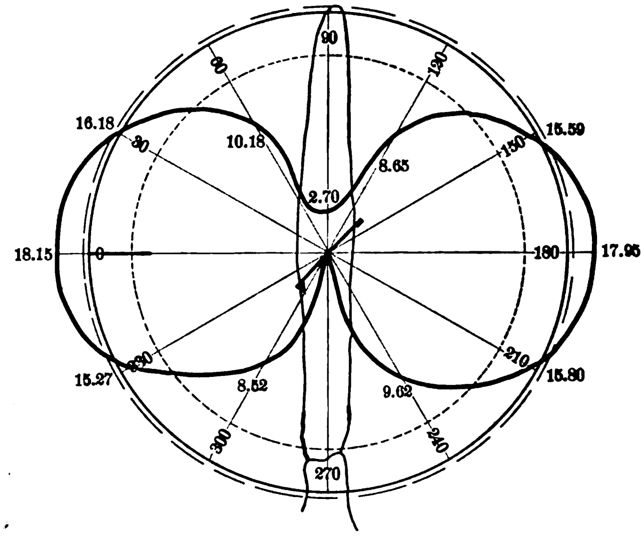

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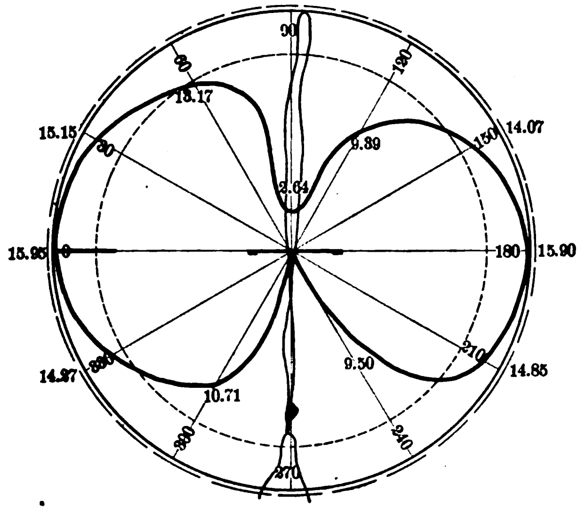
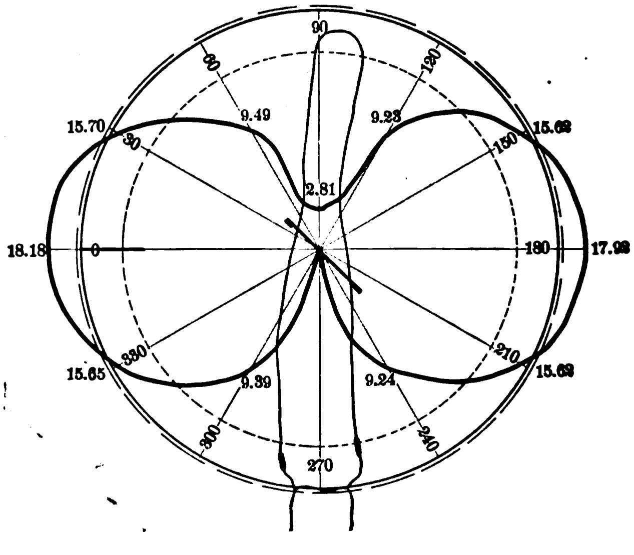


VERTICAL 135°



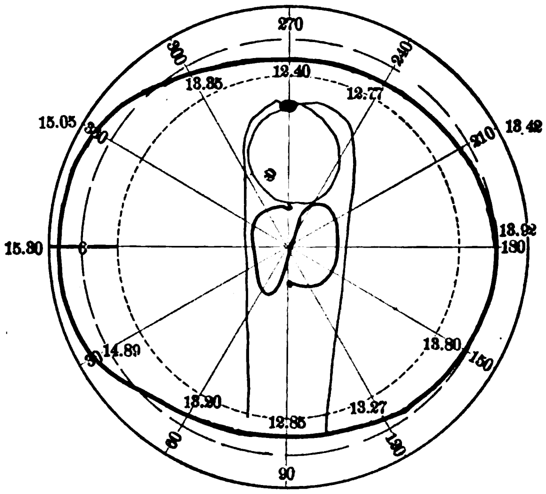
DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS.—PLATE IX.

Lamp.—Swan, 92 volt. 16 c. p.
Mean standard reading = 15.30.
Mean spherical c. p. = 11.49.
Spherical reduction factor = 0.751.
Mean horizontal c. p. = 14.00.
Horizontal reduction factor = 0.915.
Mean sph. c. p. ÷ mean hor. c. p. = 0.821.
Volts = 91.98.
Amperes = 0.594.
Watts = 54.64.
Watts per mean sph. c. p. = 4.76.
Watts per mean hor. c. p. = 3.90.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = ●
Scale, 10 c. p. per inch.

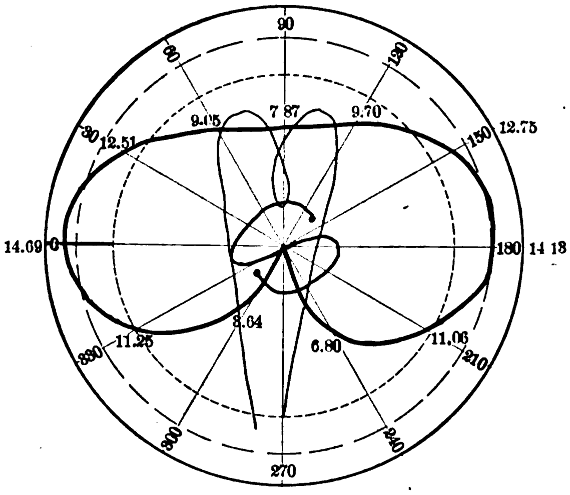
W. L. P.

Full circle reduced from 3.2″ to 2.5″ in engraving.

HORIZONTAL



VERTICAL 45°



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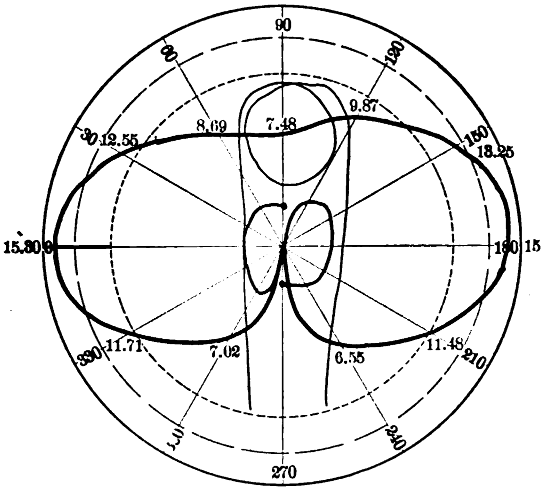

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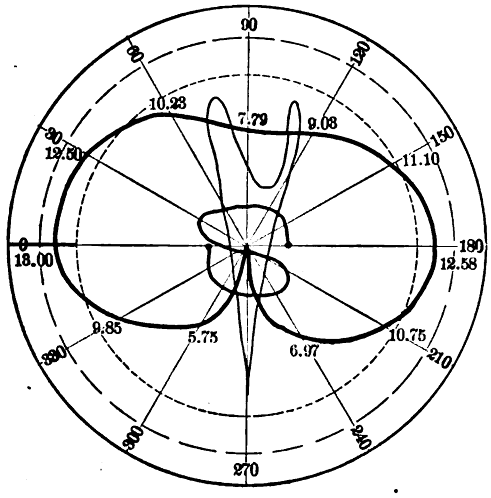

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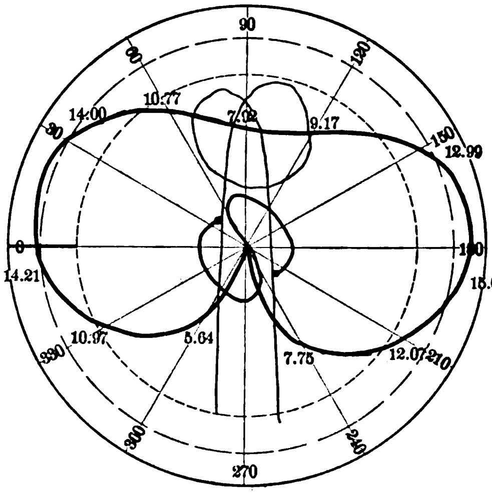

THE EAST END ELECTRIC LIGHT COMPANY'S STATION AT PITTSBURGH.

Since the East End Electric Light Company, of Pittsburgh, Pa., has finished its arc light plant, its central station has become one of the most extensive and complete electric lighting plants in the country.

Commencing with a very small number of lights, supplied by the direct current system, about three years ago, the station has kept on growing until the buildings now cover an acre of valuable ground, stocked with machinery, supplying current to no less than 16,000 incandescent and 480 arc lamps.

Its history may be very interesting, not only to electric light engineers and managers, but also to persons who contemplate the establishment of an electric light plant.

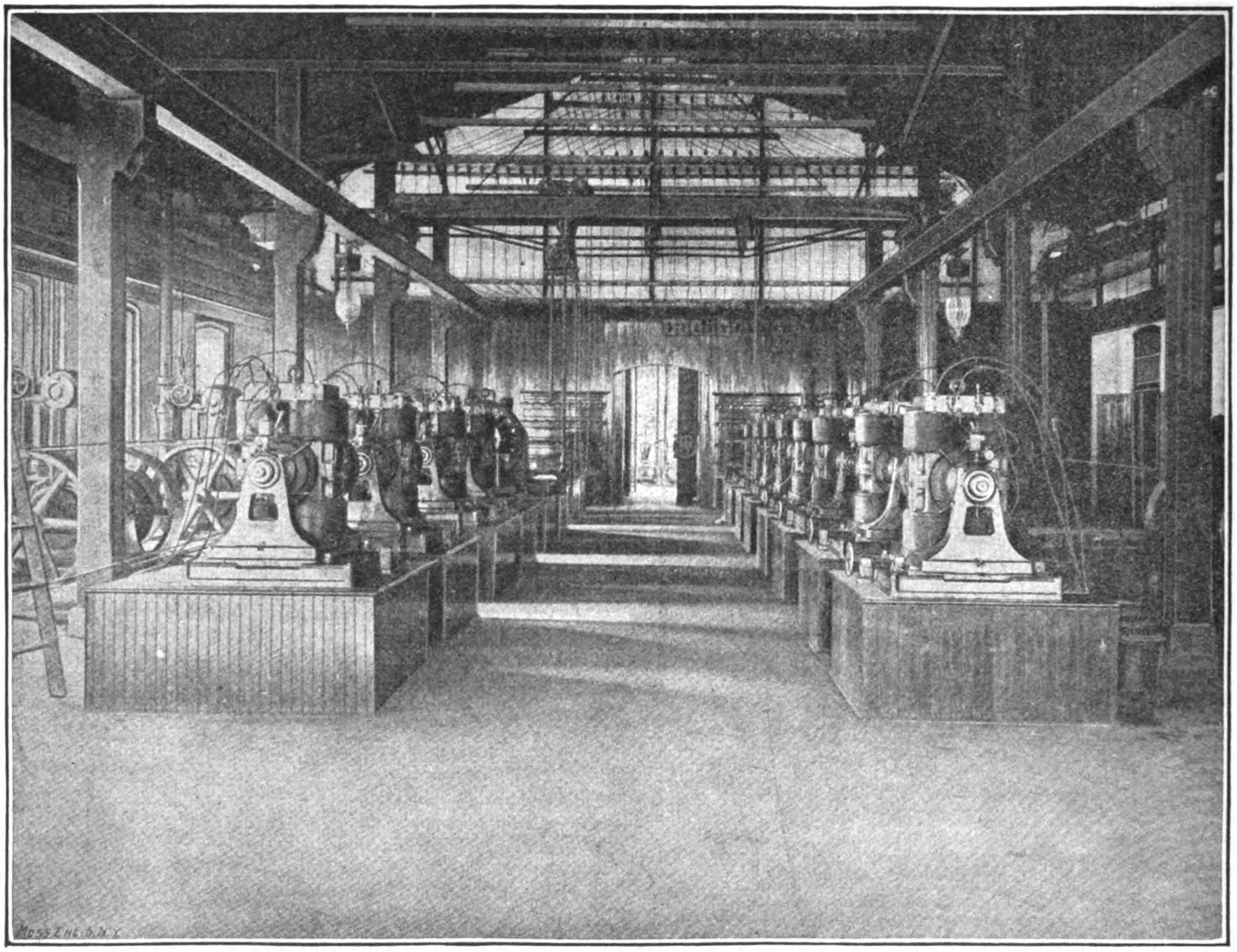

Fig. 1.—The East End Electric Light Company's Station, Pittsburgh, Pa.—Arc Dynamo Room.

The East End Electric Light Co. was organized January 20, 1886, and began operations with a 300-light Westinghouse direct current dynamo and a 45 h. p. Westinghouse automatic engine. This plant continued in use for over a year, during which period the increase of business and corresponding outfit was very slow. In consequence, the directors of the company decided in June, 1887, to adopt the Westinghouse alternating current system, which had been successfully introduced throughout the country during the preceding year, and had already gained well established favor. A new building for the central station was erected on Broad street, East End, and this structure was soon equipped with Westinghouse alternating current apparatus for a capacity of 3,900 lights. Two 1,300-light dynamos were placed in position, as well as two 650-light machines, with two 150 h. p. and two 75 h. p. Westinghouse automatic engines. In addition, the plant included two Westinghouse No. 8 exciters driven by two 25 h. p. Westinghouse automatic standard engines. Four 100 h. p. Riter & Conley boilers constituted the steam battery of the plant. The most improved electrical appliances were utilized in fitting up the station, and when in March, 1888, operations were commenced, it was generally conceded that the East End company possessed a model electric lighting plant.

From the first day of its operation evidences of the success of the new plant were everywhere recognizable. The alternating current system of distribution effected marked improvement in meeting the demands of the service, and the business of the company increased very rapidly. The furnishing of electric lights to private houses was immediately undertaken, and in that direction marked success was the result. Applications became so numerous and so urgent that repeated enlargements of the plant had to be made. When the company found itself thus securely placed upon a solid basis of business, the management deemed it advisable to enter the field of arc lighting. A lot adjoining the incandescent station was purchased, and in February, 1889, ground was broken for the building which now contains the arc light plant. This outfit was completed a few weeks ago, and the two electric light buildings, with their contents of incandescent and arc apparatus, are briefly described below.

On entering the arc light building from Broad street the visitor instinctively halts at the threshold to enjoy the interesting vista before him:—a spacious, lofty, well-lighted hall, filled, but not crowded, with machinery conveniently and symmetrically disposed. The floor is covered with asphalt, and as smooth as a skating rink. Standing at the door two rows of arc light dynamos arrest the observer's attention. There are six Waterhouse arc light dynamos, of 35 lights capacity each, on either side, and at the farther end is a new 60-light machine of the lately devised Westinghouse arc light system.

Behind the machines runs an underground conduit, into which all the wires from the dynamos are conducted. From this conduit they go to the switch-board, and from there to the top of the building into a cupola, from which they are distributed to the overhead mains on the adjoining streets. A door from the dynamo department leads into the boiler-room. There are two batteries of two Babcock and Wilcox boilers, each 240 h. p. The boilers are so piped that each boiler or each battery can be used independently or all together. The boilers are supplied with natural gas fuel at a uniform pressure of twelve ounces.

The engines are all furnished by the Westinghouse Machine Co., the directors of the East End company preferring them for their great efficiency and economy, as well as their convenience. There are four "Compound" engines of 80 h. p. each; three "Automatic" of 75 h. p. each; and one "Automatic" of 60 h. p.

The arc light house has been built to admit of machinery for a capacity of 1,000 arc lights.

The incandescent light building is large enough to hold six 3,000-light alternating current machines and two exciters. The present complement consists of five dynamos, viz.:—two of 3,000 lights capacity, two of 1,500 lights, and one of 750 lights. The present outfit of engines is as follows:—one "Compound," 250 h. p.; one "Duplex," 250 h. p.; six "Automatics," viz.:—one 200 h. p.; two 150 h. p.; one 125 h. p.; and two 25 h. p. The machines are arranged in a manner similar to that employed in the arc light station house. Everything has been arranged on one floor, and from any point in the room the entire outfit of machines and apparatus can be overlooked. The advantage of this is obvious when it is considered that on this account the force of attendants can be reduced to a minimum. Only one engineer and one fireman are required during the day, while at night but two engineers are necessary. This concentration of apparatus, together with the relatively little attention required by alternating current dynamos, enables the East End company to man its station with a remarkable economy in the labor account.

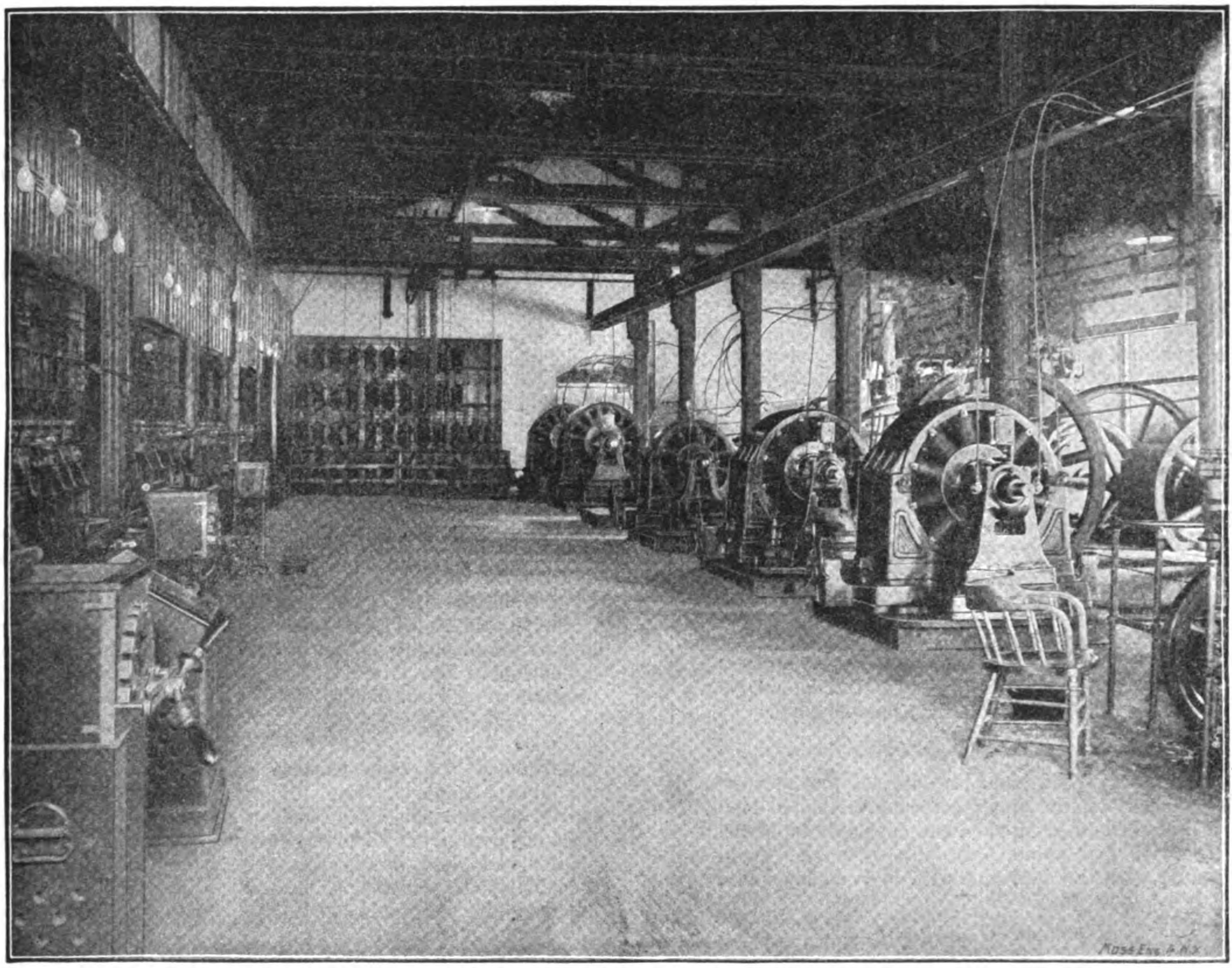

FIG. 2.—THE EAST END ELECTRIC LIGHT COMPANY'S STATION, PITTSBURGH, PA.—INCANDESCENT ROOM.

The company is a pioneer in supplying incandescent lamps to private residences. Four hundred houses, with 7,000 lights, are now served from its station. All customers of the company are furnished with an alternating current meter. The company also supplies fourteen churches with the electric light. The most distant incandescent lamp is situated five miles from the central station.

The switch-board in the incandescent station also deserves mention on account of its extremely convenient arrangement for ready manipulation. All the switches are placed in a single row on one wall.

INVESTIGATION OF THE MAGNETIC SUSCEPTIBILITY OF VARIOUS SORTS OF IRON AND STEEL.[1]

BY W. NEGBAUR.

I.

During the winter of 1888–89 I compared the magnetizibility of various kinds of iron and steel, and, as the subject is an important one, I give herewith my results, even if they are not all new.

The curves for the magnetism were investigated from their beginning all along their path to a magnetizing force of 50 C. G. S. units. Observations were made with two samples from each of twenty-two different kinds of iron and steel. All the samples were turned to uniform bars 80 mm. long and 5 mm. diameter. The measurements were made in the first position of Gauss, with mirror magnetometer, telescope and scale; the effect of the magnetizing coil being counteracted in the usual manner by a second spool. In all, about eighty series of observations were taken, each series consisting of the following: *First*, the combined effect of the two coils was reduced to zero (this being verified by the use of various strengths of current), and then the rod laid in the spool. I then let the current increase gradually from zero to the maximum the wire would admit of, during which process sixteen deflections and the corresponding currents were observed. The current was commutated and again gradually brought back to zero, during which time, at eight stages, as many observations were made with the now opposite magnetism.

The values, however, for the specific magnetism shown in table 5 are for *increasing* current, so that it is possible to compare the different curves with one another. With decreasing current, the values for the magnetism of the steel rods, by reason of the residual magnetism, fall more slowly than those of soft iron pieces, so that a glance at the different curves would give a false idea of the general susceptibility of the various sorts of iron.

II. NOTATION AND PRELIMINARY CALCULATION.

Let

M = magnetism, in C. G. S. units.
H = horizontal *intensity of earth's magnetism.*
r = distance in cm. of sample from magnet.
n = number of windings on the spool.

(1) Calculation of the magnetizing force.

The average weight of the samples was 13 grams. If we demand as a maximum, a specific magnetism of 180 C. G. S. for the best sorts of iron, then the magnetic moment of a rod is 13 × 180, or about 2,400 C. G. S. units. From Müller's formula with the constants of von Waltenhofen.

$$M = 14.4\, l\, d^2 \text{ arc } tang\, \frac{n \sqrt{l}}{5300\, d^{\frac{3}{2}}}\, i,$$

and the magnetizing force $n\, i$, for $M = 2400$, is

$$n\, i = 7500 \text{ C. G. S.}$$

(2) Calculation of distance of rod from magnet.

In order to retain the scale in the field of the telescope, the distance r, of the bar from the magnet, was calculated from the equation

$$tang\, \alpha = \frac{2\, M}{H\, r^3}$$

when, for the greatest allowable deflection of 50 cm. the scale was removed 160 cm. from the mirror.

Then
$$r = \sqrt[3]{\frac{2\, M}{H\, tang\, \alpha}},$$

and by substituting these values ($M = 2500$; $H = 0.186$ and $tang\, \alpha = \frac{a}{2\, b} = \frac{50}{2 \times 160}$) r = nearly 60 cm. M is purposely taken larger, as the above formula gives too small dimensions for our rods.[2]

III. PLAN OF THE EXPERIMENT.

The magnetizing force was induced by means of a bobbin with a cylindrical opening for the magnet. The dimensions of the bobbin were:—Length, 8.4 cm.; external diameter, 3.8 cm.; internal diameter, 0.8 cm., the winding being 504 turns of 1.2 mm. wire with single cotton insulation—the wire carrying as a maximum 15 amperes. The maximum current demanded an arrangement for cooling the bobbin, and this, after many trials, was satisfactorily accomplished by dropping oil. The second bobbin, *k*, was as nearly identical in every respect with the first as it was possible to make it. It lay, however, not rigid like K, but was movable, to allow its action being made equal to that of K. Besides this, K was set somewhat lower than K, so that the image of the scale could be seen in the telescope. The arrangement of the apparatus was as represented in figure 1. The spool K would alone excite a system of lines of force. By the addition, however, of the spool *k* the lines of force excited by K would be forced back, allowing the mirror to stand in the "indifferent" points of the two bobbins. The mirror and its magnet now being horizontal to the bobbins, any deflection of the mirror would depend upon the magnetic moment of the iron bar inserted in K.

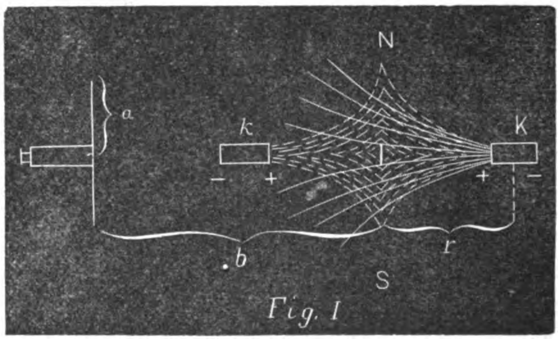

Fig. I

IV. CORRECTIONS.

Although the rods became warm when excited, yet we may neglect the influence produced by the rising temperature, as the inaccuracies lie always within the limits of error. The slight irregularities in the form of the rods had, however, a very great influence. The lengths of these were so exactly alike, that the difference in the magnetic moments must be ascribed to varying thicknesses.

These thicknesses being difficult to determine, the corrections were made with the greatest accuracy by simply considering the weight. Curves were constructed for the magnetic moment of each of the two samples of the same metal. The average difference corresponded to the difference in the weight of the samples, and this could be determined to any desirable degree of exactness. The mean of the differences between the various pairs of curves gave, when referred to the unit of weight, a constant, by the help of which the mean of the magnetic moment of two similar rods was corrected.

All values were calculated in percentages. If, for instance, the average of the weights of two similar samples was 2 per cent. greater than the average of the whole number of rods, then the values for a curve which was to be the mean of these two curves were reduced by twice the amount of the constant (in percentage).

It will be noticed that some values of the corrections expressed in units of weight, show important deviations, yet the mean of these corrections would not be very much influenced by this circumstance.

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[1] Translated from the German by P. J. McFadden.

[2] Wiedemann, d Lehre v. d. Electr. Bd iii., §460.

V. CALCULATION.

Let
a represent corrected deflection in mm.
b represent distance of scale from mirror in mm.
In the 1st position of Gauss

$$M = \frac{tang\ \alpha\ H r^3}{2} \text{ when } tang\ \alpha = \frac{a}{2\ b}$$

Therefore,

$$M = a \frac{H r^3}{4\ b}$$

Finding the value of the expression $\frac{H r^3}{4\ b}$ gave me a constant which is dependent only upon the horizontal intensity of the earth's magnetism, and upon the manner of setting up the apparatus. In the present case, when $b = 1610$, the expression $\frac{H r^3}{4\ b} = 6{,}239$. The magnetic moments were reduced to units of weight. The specific magnetism, M_s (that is, that magnetic moment which one gram of iron receives with a certain current), was found by dividing the constant by the average weight of the bars. This weight was, 13.112 grams.

Therefore,

$$M_s = a \frac{6.239}{13.112} = a \times 0.4757.$$

The deflections, corrected according to IV., are presented in the following table. Each corrected value having been multiplied by the above constant, 0.4757, the figures give, consequently, the specific magnetism.

The figures above the double line give the magnetizing force in absolute units.

That this iron is capable of being cast makes it especially suitable for the construction of dynamos and transformers. Of all the steels those of Bessemer and twice-refined "Loewen" steel proved themselves the most readily magnetized. The greatest difference observed in the samples examined was 31.6 per cent.

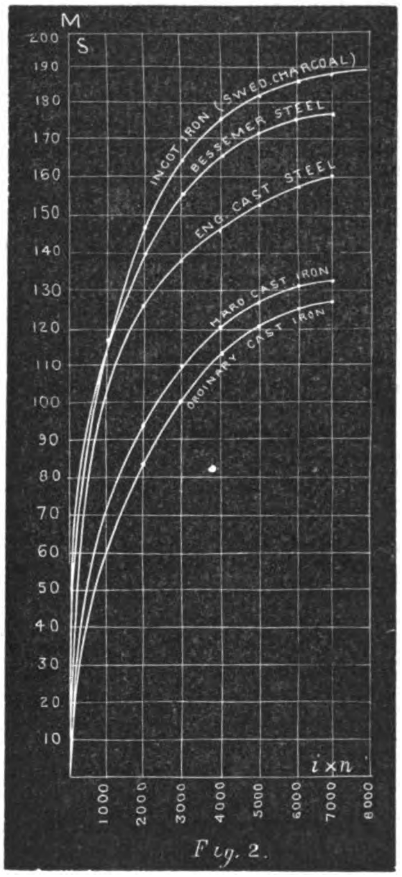

Fig. 2.

Kind.	Source.	Remarks.	500.	1000.	1500.	2000.	2500.	3000.	3500.	4000.	4500.	5000.	5500.	6000.	6500.	7000.	7500.	8000.
Ordinary cast iron......	Krigar & Ihsen	Granular (coarse)	....	......	80	88.5	96.5	104	111	116.5	121	125	127	128	128.5	......	......	......
Stove iron......	....	Gran. (fine) hard	...	......	......	98	105	111.5	117	122	125.5	129	131.5	133	134.3	134.8	135	......
Malleable cast iron.. ...	....	Soft	....		120	126	131.5	135.2	139.7	143.7	146.8	149	151.8	154	155	156.5	157	......
Bessemer steel..........	....	....	....	112.8	130	143	152.5	160	164.3	168.5	171.4	173.8	176	177	177	177	......	......
Griff steel..............	Westphalia Union	Once refined	....	109	125 4	137.2	146.4	155	157.2	162.5	164.9	168.2	170.5	172.5	173	173	......	......
Lowen steel	"	"	...	......	123	133.5	143	150.8	156	160	163	165.4	168.2	170	171	171	......	......
" "	"	Twice refined	...	112	127.5	150	156	161.2	164.9	169.5	171	173.3	174.7	176	176.5	177	177	......
Dreibrand steel.	"	Three times refined, very hard	...	......	......	138.5	148	152.7	159	162.5	166.5	169	170.5	172.5	173.4	173.8	......	......
Scythe steel	"	"	....	100	121	136	146.4	153	158	162.5	165	167.3	169.5	[170]	170.5	170.5	.....	......
English cast steel........	Seebohm & Dickstahl (Sheffield)	.. ..	...	......	122	130	137.2	142	147.5	150.8	154	157	159.5	160	160	......	......	......
German " "	Krupp (Essen)	Hard	....	98.5	122	135.5	144.7	152	156.7	161	163.8	167	170	171.5	172.5	173	173	......
Ordinary wrought iron..	....	....	88	117	135	145	152.2	160	164.4	170	172.5	175.5	177	178.6	179	179.5	180	180
Rolled iron............	Westphalia Union	....	....	......	130	142.5	152	160	164.4	169	171.8	174.2	176.5	177.5	178	178	......	......
Ingot iron......	"	....	....	....	......	147.5	157.2	164.4	171	175.5	179.5	182.1	184 7	186.6	188.5	188.5	188.3	188
Ordinary German iron..	Turned out f'm nail	Soft	...	.....	......	136.7	150.5	157.5	163.8	169	172.5	175.5	177.5	180	181	181.5	182	......
" English " ..	Turned out f'm key	"	....	113 5	131.5	140.2	154.5	161.7	167.8	171	173.8	176.5	178	180	181	181.5	181.5	......
German nail iron.......	Westphalia Union	Very soft	....	......	133	143.2	154	161	166.5	171	173.8	177	179.5	181.5	181.6	182.1	182.1	.....
Swedish " "	....	"	....	110.5	138	152	161	167	172.5	177	181	182.6	185.2	186.6	187.5	188	188.5	188.5
Purest Swedish char.iron	....	"	....	115.5	133.2	147.5	159	167.5	174	179	182.1	184.2	185.6	186.6	187.5	188	188.5	188.5
Ingot iron.........	Peine (Braunschweig)	....	88.2	116	133	144.2	153.5	161	166.3	171	175.5	177.3	179	180.5	181	181.2	......	......

VI. RESULTS.

In the accompanying plate are sketched some curves taken from the table. The cast iron sorts occupy the most unfavorable place, the steels the middle, and the soft irons the best place.

The single, and very important exception to this, is the case of the ingot iron, which, at least in the sample used, showed a magnetic capacity as high as the best soft iron. I verified the results respecting the high magnetibility of this ingot iron by repeated measurements with numerous other samples from the same establishment (that of Peine, near Braunschweig). Nevertheless, this iron did not show such a high degree of magnetization as similar iron from the Westphalia Union. The place then, of the ingot iron lies between the steels and the soft irons.

Magrini[3] finds that by a magnetizing force of over 50 C. G. S. units the magnetic moment is independent of the kind of iron. In my experiments I have gone as high as a magnetizing force of 60 C. G. S. units, and my results have proved what Ewing showed, namely, that the course of the curves for the magnetism to a maximum is dependent upon qualities of the iron.

Finally, I wish to express my grateful thanks to Professor Dr. W. Kohlrausch for the kind help which he was ever ready to grant me.

Electrotechnical Institute of the Technical Hochschule,
in Hanover, Germany, April, 1889.

.... THE electrical industries are more and more demanding the experience of the mechanical engineer.—*John Perry*.

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[3] F. Magrini. Rend. della R. Ac. dei Luicei. 4; p. 734-741, 1888.

THE THOMSON-HOUSTON ARC-LIGHT SWITCH-BOARD FOR CENTRAL STATIONS.

A WELL designed and soundly constructed switch-board is one of the most important appliances required in the operation of arc light machines. There are but few central lighting stations in which commercial and street lights are not operated, making it necessary for convenience and economy to place two or more circuits in series on one dynamo, to transfer circuits from one machine to another, and to make such combinations of dynamos and circuits as local conditions render necessary. It is most desirable that there should be no extinguishment of the lights while these changes are being made, and that the construction of the board be such as to insure the operator against receiving a shock during manipulation. The switch-board here shown is designed to meet these requirements, is incombustible, and is of such construction that additions can be readily made from time to time without necessitating any changes in the part of the board having circuits already in position.

As will be seen from the illustrations, the board is made of two rectangular slate slabs, placed about five inches apart, into which are fitted rows of metal bushings; those arranged horizontally on the front board being connected to the dynamos, while the vertical rows on the back are connected to each other and the circuits. On the back there is one more row of bushings than on the front; this extra row being used to connect one circuit with another by means of the transfer cables and plugs.

The switch-board is made for four and six circuits, and is so arranged that additions may be easily made in which the number of dynamos and circuits provided for will be a multiple of four or six. The positive and negative terminals of the dynamos are connected to the left and right side respectively of the front board, and the circuits on the rear board in a like manner, the left being positive and the right negative, the bushings for the dynamos being numbered vertically, 1, 2, 3, 4, while those for the circuits are numbered horizontally, 1, 2, 3, 4. To connect a machine to a circuit the plugs are pushed through the holes on both positive and negative sides of the board, corresponding to the dynamo and circuit desired. To connect any two circuits in series on one dynamo before the machine is started the plugs are pushed through the holes corresponding to positive of one machine and one circuit, and then, by means of the transfer cable and plugs at the bottom of the rear board, the negative of this same circuit is connected to the positive of the second circuit which it is desired to place in series with the first, the final connection being made by pushing the plug through the hole corresponding to the negative of the second dynamo and negative of second circuit.

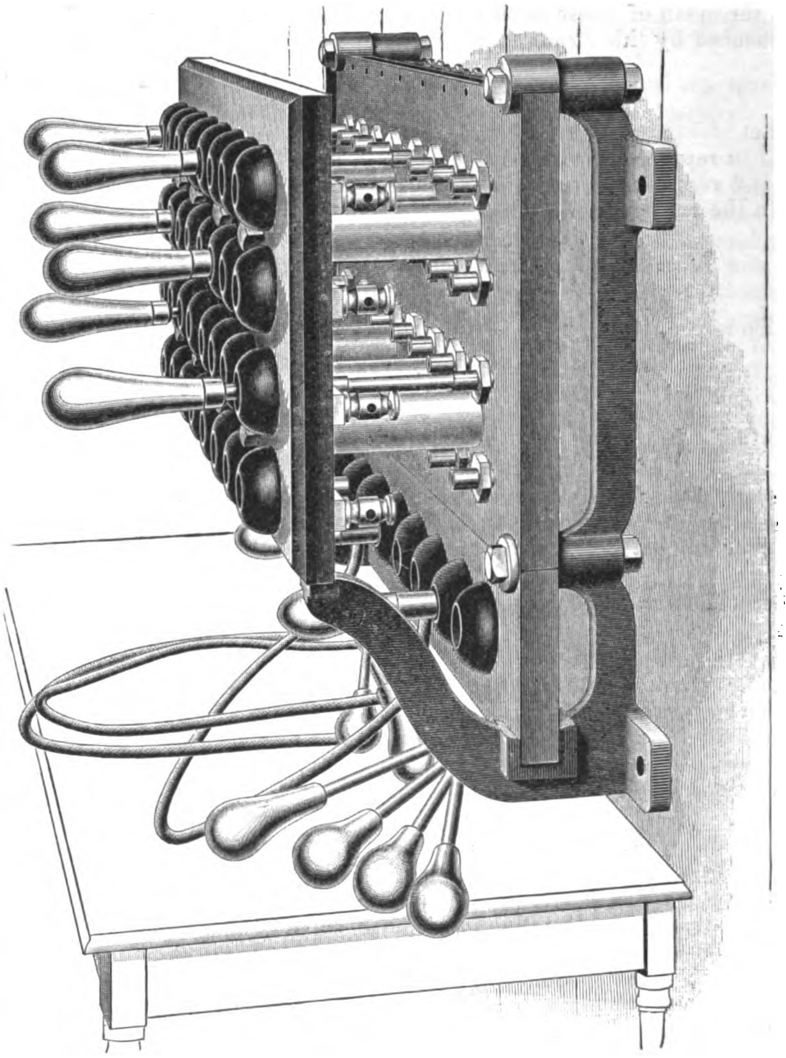


FIG. 1.

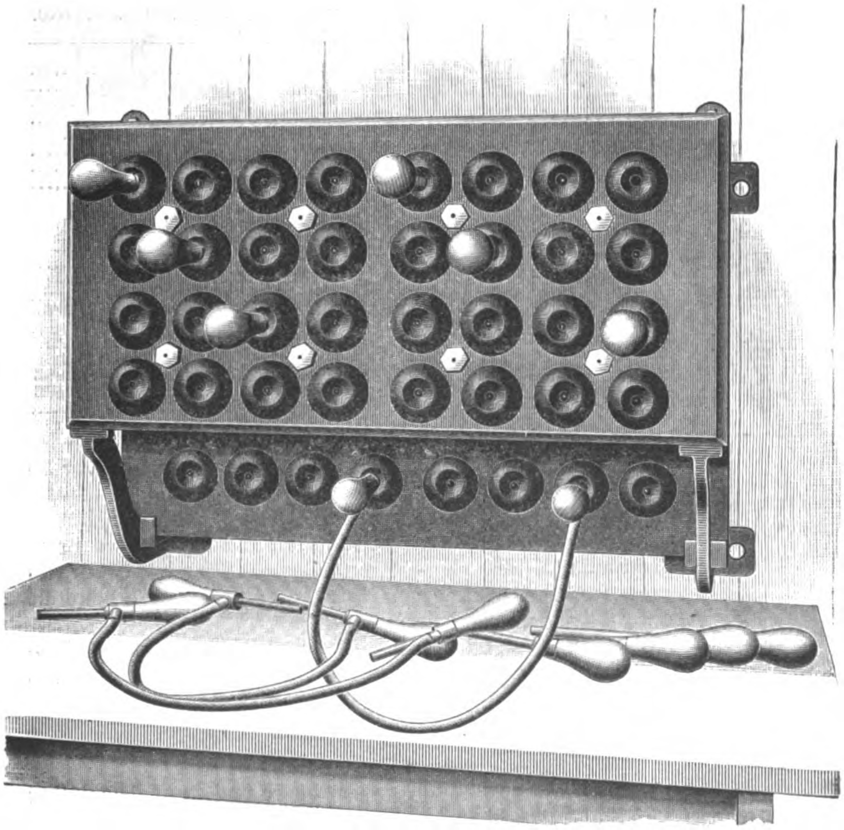


FIG. 2.

To transfer circuits from one dynamo to another when the machines are in operation without disturbing the lights, as for instance, transferring circuit No. 1 from dynamo No. 1 to dynamo No. 2. No. 1 dynamo is connected to No. 2 circuit by the plug, and No. 2 dynamo to No. 1 circuit. The circuit then can be broken between the dynamos and circuits No. 1 and No. 2, permitting No. 1 dynamo to be shut down, and the positive of circuit No. 2 connected to negative of circuit No. 1 by means of the transfer cables and plugs.

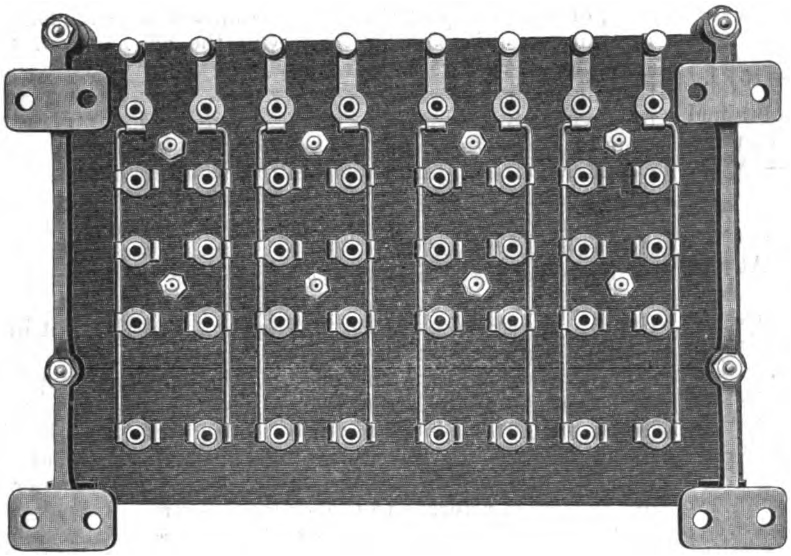


Fig. 3.

The wall space required for a four circuit board is 19x25 inches, and that for a six circuit board 24x35 inches.

ABSTRACTS AND EXTRACTS.

AN IMPROVED STANDARD CLARK CELL WITH LOW TEMPERATURE COEFFICIENT.[1]

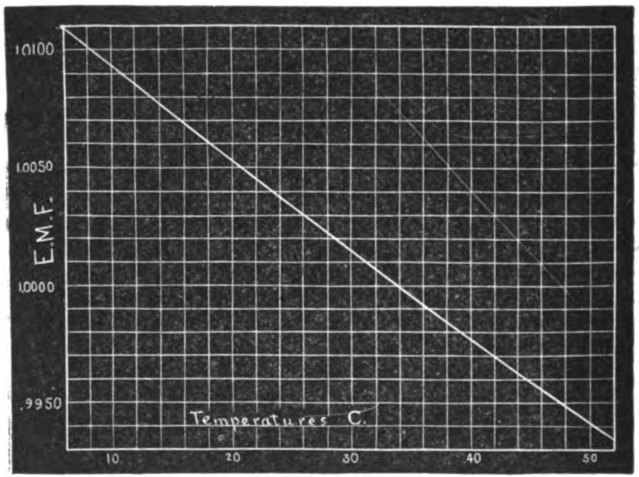
BY H. S. CARHART.

The best form of Clark cell hitherto made is that of Lord Rayleigh, described in the Philosophical Transactions for 1885. The objections to this form are that the temperature coefficient is not the same for all cells, as is shown in Lord Rayleigh's paper, and it is so high as to introduce a very troublesome and uncertain error because of the difficulty of ascertaining the exact temperature of the cell; second, it is not so constructed mechanically as to prevent the mercury from coming into contact with the zinc when the cell is subjected to violent jars in transportation; thirdly, a great chemical defect is the facility with which local action takes place between the zinc and the mercury salt. I might add that the mercurous sulphate, purchased by Lord Rayleigh, evidently contained considerable salt in the mercuric form, as is shown by its turning yellow on mixing with the zinc sulphate solution.

All these difficulties I have, at least in large measure, overcome. Respecting the materials, the greatest care is required to secure and maintain cleanliness and purity in their preparation. The mercury must be distilled *in vacuo* after being cleaned by chemical means. The zinc sulphate should be free from iron as well as other impurities. The mercurous sulphate can be made almost or quite free from the mercuric form by using plenty of mercury; keeping the temperature down to the lowest point at which action will take place; and letting the mixture of salt, acid and metallic mercury stand for some time. I have made in this way a salt that remains white, not only when the free acid is all washed out, but when mixed with the standard zinc sulphate solution. Further, it remains white in the cell indefinitely if it is not exposed to a bright light.

Hitherto, the importance of the local action going on in a Clark cell appears not to have been appreciated. It accounts for some of the differences in temperature coefficient and leads to some more serious results in some cells. The zinc replaces mercury when in contact with the mercury salt. This amalgamates the zinc, producing a slight change in the E. M. F.; and then the amalgam is liable to creep up to the top of the zinc where it attacks the solder. The copper wire is thus sometimes loosened. The zinc sulphate follows up and the cell may thus be short-circuited by the zinc and the copper wire. Upon taking down one cell, which was perhaps a year old, I found that the zinc had been removed from the rod at the surface of the liquid and had been deposited again upon the rod at the surface of the mercury salt, in a solid frill around the zinc. The copper wire in this cell became entirely detached, partly because of the expansion upward of the marine glue, which brought a severe strain upon the wire.

The local action then increases zinc sulphate in the cell at the expense of the mercury sulphate and amalgamates the zinc rod. I have become convinced by some experiments extending over several weeks that this substitution process goes on only when the zinc is in contact with the solid mercury salt. The mercurous sulphate is only slightly soluble in a saturated solution of zinc sulphate. I prevent local action, therefore, by keeping the zinc and the mercury salt out of contact. The same device operates to raise the E. M. F. about 0.4 per cent. The following table exhibits the observed and calculated values of the E. M. F. of cells No. 17, 112, 113 in terms of No. 1 [old style] at 20° C.:—



No. 17.			No. 112.		
Temp. C.	Observed.	Calculated.	Temp. C.	Observed.	Calculated.
° 8.3	1.0108	1.0106	° 5.1	1.0124	1.0125
8.5	1.0103	1.0105	10.6	1.0106	1.0103
9.3	1.0104	1.0102	12.5	1.0098	1.0096
11.8	1.0093	1.0092	15.2	1.0087	1.0086
13.8	1.0084	1.0085	19.5	1.0069	1.0069
15.0	1.0080	1.0080	21.2	1.0062	1.0062
18.1	1.0069	1.0068	31.1	1.0024	1.0024
19.4	1.0064	1.0063			
19.9	1.0062	1.0061	No. 113.		
20.3	1.0060	1.0059			
20.8	1.0054	1.0057			
21.1	1.0057	1.0056	5.1	1.0124	1.0125
21.6	1.0054	1.0055	10.6	1.0106	1.0104
22.4	1.0050	1.0052	12.5	1.0098	1.0097
23.3	1.0048	1.0048	15.2	1.0088	1.0087
25.1	1.0044	1.0041	19.5	1.0070	1.0070
26.4	1.0035	1.0036	21.2	1.0062	1.0063
30.2	1.0019	1.0022	31.1	1.0025	1.0025
33.1	1.0014	1.0013			
39.1	0.9991	0.9989			
41.7	0.9980	0.9979			
50.4	0.9949	0.9947			
52.7	0.9939	0.9940			

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[1] From the *American Journal of Science*, vol. xxxviii., November, 1889. London *Philosophical Magazine*, November, 1889.

Cell No. 1 was always very near 20° C., and the reduction to that temperature was made by means of Lord Rayleigh's reduction coefficient, .00077 per degree C.

The equation for the E. M. F., derived from the observations on No. 17, is

$$E' = E\,[1 - .000387\ (t - 15) + .0000005\ (t - 15)^2].$$

The calculated values for the three cells were all obtained by this formula. The change for one degree C. is, then, the following linear function of the temperature :—

$$-.000386 + .000001\ (t - 15).$$

The temperature coefficient ranges from .000401 at 0° C. to .000376 at 25° C., and to .000361 at 40° C. At the highest observed temperature in the preceding table it was only .000348. The curve of E. M. F. with temperatures as abscissas is clearly concave upward, indicating a fall in the temperature coefficient with rise of temperature. The change is, however, so small as to be quite negligible within the range of temperature to which a normal element is subjected in practice. Lord Rayleigh's cells show a change in the temperature coefficient directly the reverse of the above; that is, the coefficient increases by a very appreciable quantity with rise of temperature. For his No. [36] the coefficient ranged from .000556 at 0° C. to .00101 at 25° C., if his equation holds true for the higher temperature.

In making comparisons of E. M. F. I have used Lord Rayleigh's method, slightly modified, by means of which a difference of one ten-thousandth part is observed directly and with the greatest ease. In fact a difference of half that amount is easily measured. A comparison of half a dozen cells can be made in as many minutes without difficulty.

As to polarization, these cells show none with external resistance greater than 30,000 ohms. At 30,000 ohms the polarization is just discernible; and with 10,000 ohms it amounts to only one ten-thousandth part in five minutes. This fall in E. M. F. is less than the accidental differences between different cells in general, and much smaller than the almost unavoidable errors due to ignorance of the real temperature of the cell. If the cell is not closed on less than 10,000 ohms resistance, and only for a few minutes, the polarization may be entirely neglected.

As indicating the uniformity attained, the following relative values of the E. M. F. of six cells, only four days old, may be given:—9048, 9049, 9049, 9048, 9046, 9043. The last one was still approaching the others when last observed. Six cells of later construction gave the following relative values when less than two days old :—9182, 9182, 9182.5, 9182, 9182, 9182.5. The two sets of numbers do not represent at all the relative values of one set as compared with the other.

It will be seen from the table that Nos. 112 and 113 never differ by more than one part in ten thousand at the same temperature.

EFFICIENCY.[1]

BY PROFESSOR DE VOLSON WOOD.

THE term "efficiency" in mechanical science has become technical, and is restricted to a definite mathematical expression in the form of a ratio. When thus used its meaning is well understood, but its importance is increased by giving to it a broader definition, and a wider range of applications.

Efficiency is a result compared with the effort expended in producing that result.

This implies a division, and, therefore, may be expressed as a fraction, and, if it be abstract, a common unit must exist between the effort expended and the result obtained. If one be in thermal units, the other should be; if one be in pounds, or dollars, or feet, or time, or any particular quality or quantity, the other should be, respectively, the same. We will illustrate these principles by a few examples. Beginning with the familiar one of the steam engine we may have the following efficiencies :—If 10 per cent. of the energy of the steam admitted into an engine be transmuted into work, then will the efficiency of the steam, compared with the energy in it when admitted to the engine, be one-tenth or 10 per cent. If five per cent. of the energy of the steam in the boiler be lost by radiation, leaks, friction, etc., in passing from the boiler to the cylinder of the engine, then will the efficiency of the steam, compared with its energy in the boiler, be 0.10 × 0.95 = 0.095, or 9½ per cent. If the efficiency of the boiler be 0.70, that is, if the boiler utilizes 70 per cent. of the theoretical heat of the fuel, then will the efficiency of the system referred to the fuel be 0.095 × 0.70 = 0.0705, or more than seven per cent. If the fuel be coal, and the heat in it be one-fourth that in the plants from which it was produced, then would the efficiency of the system, compared with the heat in the plants from which coal has been produced, be 0.017625. If the heat energy in the plants be one per cent. of the energy received from the sun (and this is probably a *very* high allowance), then would the energy of the system referred to the original source of energy—that of the sun—be 0.0017625, or less than one-fifth of one per cent. We have referred to the sun as the original source, for we are ignorant as to *its* source of energy. Speculation is not agreed in regard to it; it may be the result of combustion, or of a shrinkage of volume, or the impact of external masses—or it may be an expenditure of original energy, and in these speculations it is generally assumed that the entire mechanical energy expended is entirely transmuted into heat, in which case the efficiency of such heat operation would be unity.

The efficiencies here given are less than unity, and it is always less than unity when the result is obtained from the source without an intermediate agency, deriving more or less power from another source. When the latter condition is involved, the efficiency may exceed unity. For instance, if money be carried, or deposited with another without being used, its efficiency could not exceed unity, and, although practically the efficiency may be unity, yet, considering friction, wear, tear and accidental losses, it is liable to be less than unity. If, however, the money be loaned and the borrower uses it in trade, commerce or agriculture, he may be able to pay for the use of it, and if he pay six per cent. periodically, the efficiency to the lender will be 106 per cent. If the borrower expended the money in raising a crop of wheat and received five times as much money for it as he expended, the efficiency would be 5—or 500 per cent. In this case the soil and other elements of nature constituted an intermediate agency which contributed to the result independently of the money expended in labor, seed, etc. If, however, the crop be referred to the wheat-producing capacity of the soil—that is, if the chemical elements of the wheat be compared with the corresponding chemical elements in the soil—the efficiency would be less than unity, and might be only a very small fraction.

The efficiency of a refrigerating plant is, by some, referred to the thermal units of work done on the fluid by the compressor, in which case the efficiency exceeds unity; for the compressor, in practice, adds only a small part of the heat that is removed by the refrigerator, the other part being absorbed by the circulating fluid from substances not affected by the compressor, and the latter measured by the work of the former. Even in this case, the efficiency may fall below unity when the result is compared with the energy expended in operating the compressor.

Negative efficiencies are ideal, and are not reported in practical operations. Since all efforts, all work, all heat, all energy, are positive when considered by themselves, negative efficiencies exist only in the *sense* in which one effort is considered in reference to another. Thus, steam in an engine does work, but air admitted to a compressor does no work, but work is done upon it. In the sense of the fluid in a compressor doing work, the efficiency is strictly zero, and in the sense of *its* doing work when driven, it is negative. Again, if a man promised to pay five bushels of wheat for the use of a wheat field and the crop were an entire failure, the efficiency of the crop would be zero, and if he delivered the five bushels according to agreement, he would necessarily secure it from some other source, and the efficiency of the transaction would be negative.

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[1] From *The Stevens Indicator*, October, 1889.

As for an *imaginary* efficiency it has too often proved a *reality* to *visionary* dealers.

It is unnecessary to illustrate further, and we will simply mention a few other subjects to which it is, or may be, applied. The efficiency of a beam is the ratio of the load it carries to that required to break it, and is the same as the factor of safety. We have the efficiency of riveting—of belt transmission—of the flow of fluids through orifices and pipes—of a bank—of an instructor—of a student—of an institution of learning—of a journal—of an official, etc. Many of the latter cannot be expressed mathematically, for the quantities do not admit of exact measurement. While it may be said that one man is more efficient than another, yet if it be said that he is twice as efficient, it will be considered as a matter of judgment, and not the result of measured quantities.

RULES FOR ISOLATED LIGHTING PLANTS.

MR. EDWARD ATKINSON, President of the Boston Manufacturers' Mutual Fire Insurance Company, issues a special circular, as follows:—

HAZARD FROM OUTSIDE ELECTRIC CURRENTS.

Electric lighting was first introduced in a very few risks insured by this company before the year 1881; in that year and in the first six months of 1882 it was adopted in a very considerable measure. In this period of its early introduction, prior to the 1st of April, 1882, we received notice of 23 fires which had been set by the electric current in only 61 mills which had then been equipped. No claim for loss was made on any of these fires, but they disclosed conditions which were very alarming to us. An immediate investigation was made, under the direction of Mr. C. J. H. Woodbury, and certain rules were adopted for putting up the apparatus, insulating the wires, and guarding against the dangers disclosed in these 23 fires. These rules were immediately submitted to all the electric light companies or manufacturers of electric lighting apparatus who had any standing in the community, and were at once adopted by them as well as by all insurance companies. They have not been changed since that date, except so far as new inventions have called for modifications.

Since April 1, 1882, a period of nearly eight years, we have received no notice of any fire which could be attributed to electricity in any risk insured by this company, and, of course, no claim has been made upon us for a loss which could be attributed to this cause. Our experience, therefore, justifies the conclusion to which we came after the first two years of electric lighting, that, under proper safeguards, it is the safest method of lighting that can be introduced. Electricity has also been applied in some of the works insured by us as a motive power, and electricity is now applied to lighting or motive power in over 600 risks which are insured by the Factory Mutual Companies.

Attention, however, has lately been called to the danger of wild currents of electricity generated on the wires which may be in use for lighting, for power, and for the railway service in many cities. There appears to be very little doubt that the recent destructive fire in Boston originated in the diversion of a high tension current of electricity from its own wire to an electric clock wire, on which it was carried to the building in which the fire originated. There appears to be little doubt that this conflagration may be attributed to the lack of precaution in guarding against an outside current of electricity. Such currents may be carried from their proper wires to other points in all cities or towns in which electric light or power is widely distributed on the public streets or over private buildings.

In order to guard against this hazard, the owners and managers of mills and works insured are advised to establish the following rules for the protection of their premises. These rules, after having been drawn by us, have been submitted to experts in various branches of electric science, who are of the highest authority. The forms have been modified by them, again considered on our own part, and are believed to be suitable for what may be called an emergency.

RULES FOR GUARDING INSURED PROPERTY AGAINST THE HAZARD OF STRAY CURRENTS OF ELECTRICITY GENERATED OUTSIDE OF MILL YARDS.

1st. No foreign wires of any kind shall be attached to buildings insured by this company, for the purpose of carrying electric currents across the yard to any point.

2d. All electric wires which may be required by the insured shall enter the premises at one point near the head-quarters of the night watchman, where they can be kept under supervision; each of said wires shall be guarded by a protector against strong currents, operating by opening the circuit, and by a lightning arrester.

3d. Such protectors against strong currents shall be located in a dry, accessible place inside the building, and as near the point of entrance of wires as possible, and shall be without ground connection; such protectors shall be mounted on non-combustible and insulated supports, which shall be provided with a receptacle for the burning or melted parts of such apparatus.

4th. The lightning arresters on all wires must be placed between the protector against strong currents and the electrical portion of the apparatus within the building to which such wires are connected. No ground wires for such lightning arrester shall be attached to gas pipes within the premises of the insured.

5th. All electric wires which may enter the premises of the insured must be insulated, between the line wire on the insulator attached to the buildings outside and the protecting device within, with the best quality of waterproof insulation. Moreover, such wires must enter at a distance of not less than three (3) inches from any other wire or any conducting material.

6th. If any wires carrying high tension or strong currents are to be carried over or under other wires on the property of the insured, they shall be attached to poles so near to each other, with one wire so far above the other, that, if a break should occur, the pendent wire between these poles may not be long enough to come in contact with the wire below, or, if not carried on poles, these wires shall be so placed or protected with guard wires as to render a contact between different wires impossible.

7th. If the high and low tension systems are in use in the same yard, even when developed within the works, the wires must be kept separate, and so wide apart that no contact or cross arc can be made.

If any changes are to be made on which any advice is required, in order to establish the safeguard herein recommended, an inspection can be made.

KEARNEY, NEBRASKA—ITS PROSPERITY.

THE City of Kearney, Nebraska, is just half-way between Boston and San Francisco, being 1,733 miles from each of those cities. It is probably a surprise to many residents of New England to learn that the population of Nebraska is greater than that of Connecticut and Rhode Island combined, and nearly equal to that of Massachusetts. Kearney—the midway city—with a present population of more than 10,000, is in its growth and enterprise one of the most typical of western towns. Only a few years ago the Chicago, Burlington and Quincy railroad managers thought it would be folly to build further west than Lincoln, but now Kearney has two railroads at its doors, four from 40 to 100 miles distant, and half-a-dozen more reaching out towards it as rapidly as possible. The business men of the city reach out for nothing short of a large slice of the general business of the Northwest, and they seem to be getting generous bites off it already. The town is of special interest to the electrical fraternity, as being the head-quarters of the Western Enginering Co., electrical engineers and contractors, established at first some two years ago at Lincoln, by Mr. D. C. Jackson and Mr. J. G. White, soon after their graduation from Cornell University. Readers of THE ELECTRICAL ENGINEER are familiar with the names and work of both these gentlemen, and will be glad to learn of the prosperity that has attended their bold push to the west, where they carried their knowledge and trained abilities in the interest of electric arts and their own fortunes.

.... WORDS, we know, though but wise men's counters, are the money of fools.—*S. P. Langley.*

.... I WAS the first to show that sheets of paper could be made to insulate, so as to be available for the construction of condensers. I originated the idea of constructing artificial submarine circuits, and suggested their use as a means of solving by direct experiment the problems connected with submarine telegraphy.—*S. Alfred Varley.*

.... I KNOW of nothing which requires a more general exact knowledge of the mechanical, electrical and other properties of materials, and the strength and stiffness of structures which may be subjected to local heating, than the design of the armature of a dynamo.—*John Perry.*

CORRESPONDENCE.

NEW YORK AND VICINITY.

No Electric Lights in Roman Catholic Churches.—Mr. Edison and the Grand Jury.—The Electric Lighting Companies Preparing to Sue the City for Damages.—Subway Explosions.—Mr. Edison's Kind Attention to Some Bright Boys.—Electric Welding Adopted by the Bishop Gutta Percha Co. and the J. A. Roebling's Sons Co.—Prompt Restoration of Full Service by the Edison Company after Destruction by Fire of its Down-town Station; the Proposed New Station.—The New Building of the Edison General Electric Co.—Ex-Mayor Hewitt on the Subway Commissioners.—Resignation of Commissioner Gibbens.—Darkness and Disasters.—The Delany Line Adjuster Used at the Jersey City Office of the Erie Railway.

ONE of the few churches in the country which has adopted the electric light is that of the Holy Innocents in this city. It is to be dispensed with hereafter, however, the Sacred College of the Propaganda in Rome, after mature deliberation, having decided that electricity should not be used for the illumination of sacred edifices.

Mr. Edison appeared before the Grand Jury in this city in December, and, although all hearings before that body are conducted with every possible precaution against publicity, it is reported that the distinguished inventor suggested that a law be enacted prohibiting the use of electric currents of such a character as to be dangerous to life.

When the work of destroying electrical property by the city authorities finally ceases, the various electrical companies will proceed to write up their books with a view to bringing suit against the City of New York for damages incurred, which will make a pretty large bill. It is said that the amount to be sued for by the East River Electric Light Co. alone will exceed $250,000, and it is safe to say the total will exceed $1,000,000.

It is over a year since the first serious gas explosions occurred in the electrical subways, and it was supposed that steps had been taken to prevent them; for there is no question that they are a menace to human life, which with the extension of the subways will, of course, be greatly increased. There have been two explosions within a month, one of which, at the corner of Fourteenth street and Sixth avenue, made a total wreck of the man-hole. Those which have occurred heretofore have not caused sufficient damage to require much time for repair, but in this case passers by had an opportunity for two days to witness the powerful explosive effects of the accumulated gas which seems to pervade the entire subway system.

The doll industry at the Edison phonograph works in Orange, N. J., is said to be in a flourishing condition, the factory being well stocked with parts of dolls which will be put together at once. A delivery of fifty dolls was made on January 3d, and it is thought that within a month there will be an ample supply placed on the market.

The Huyler candy factory, corner of Eighteenth street and Irving place, has been fitted out with electric motors for its machinery, which is distributed through six floors. A saving of 25 per cent. in the coal bill of the establishment has been guaranteed.

Two city boys have recently completed a miniature launch which they have placed in commission on the yachting lake in Central Park. It was christened the "Edison," and is operated by a bichromate battery. They were so well pleased with its success that they wrote a letter to Mr. Edison containing a description of the craft. In his reply to the boys' letter Mr. Edison highly complimented their work, and at the same time suggested a more suitable battery, kindly giving detailed instructions as to its arrangement.

The Bishop Gutta Percha Co., of this city, and the John A. Roebling's Sons Co., of Trenton, have adopted electric welding in their respective factories for the joining of the ends of wire. This process appears to be admirably adapted for the purpose, and will no doubt be gradually introduced into all similar establishments.

The Edison electric light station at 255-7 Pearl street, which was completely burned out by fire January 2d, has been refitted and was again in full operation in a fortnight. Meanwhile the auxiliary station of 5,000 lamps capacity, on Liberty street, has been kept in continual service. The Pearl street station will be used until the completion of a new down-town station, which will be located just above the approach to the East River bridge. The construction of this station will begin next spring, and it is expected that it will be finished during the year.

The Edison General Electric Co. has filed plans for the construction of an office building at Nos. 42 and 44 Broad street, running through to Nos. 38 and 40 New street. It will be ten stories high, 41 feet front and 143 feet deep, and will cost $250,000.

Ex-Mayor Hewitt, in commenting on his attitude towards the electric wires during his administration, says that he never saw such appalling ignorance as was displayed on the subject by Messrs. Moss, Hess and Gibbens. He admitted that he was ignorant; but said, "they did not know enough to know that they knew nothing of the subject."

Mr. Gibbens has recently resigned from the board of electrical control. Various reasons are assigned for his action, but it is believed to be due to the adverse criticism of the press. It is also thought that he may be a candidate for a position on the new state board, the salary for which will be $3,000 in excess of what he has heretofore received. It is stated that his successor will be an electrical man.

Since the suspension of arc lighting on the river fronts, two men have plunged into the East River, while under the supposition that the lights on the Brooklyn side were at the boundaries of New York city. The police have restrained several pedestrians from attempting to walk over on the water, in spite of the fact that the fare on the bridge is only one cent.

The New York, Lake Erie & Western R. R. Co. has just placed in use at the Jersey City telegraph office the Delany adjuster, recently introduced to insure a working adjustment of instruments in all kinds of weather.

NEW YORK, January 23, 1890.

PHILADELPHIA.

Councils Still Considering a Municipal Electric Lighting Plant.—The Lighting Contracts for Another Year.—A New Gas and Electric Fixture Company.—Overhead Wires in Camden, N. J.—Prosperity of the Bell Telephone Co. of Philadelphia.—Complaints that Arc Lights are Not Up to Candle Power Required.—The City Will Try to Devise and Enforce a System of Tests for Next Year.

BOTH branches of city councils concurred in a resolution presented by Mr. M. C. Smith, requesting the joint special committee of the two chambers, appointed to consider the advisability of establishing an electric light plant for the city, to report early in January, giving a detailed statement of the cost of construction of such a plant and the cost of maintenance.

Mr. Smith stated that a plant of 1,200 lamps could be constructed at a cost of $300,000, and that $90,000 would be required each year to maintain it. This plant would do away with nearly 3,000 gas lamps.

Representatives of the various electric lighting companies in Philadelphia were in conference recently with Superintendent Walker and Director Wagner, concerning the terms under which contracts for electric lighting will be made next year. It was determined that bids shall be made according to amperage and voltage, the proposals setting forth the amount of the current to be furnished and the voltage of each lamp. Each circuit will be provided with a test station, so that city employés can ascertain at any time the strength of the currents passing over the wires. The standard required of the lamps will be 1,000 c. p.

Recent tests have shown that the city lamps lose 27 per cent. of their brilliancy by reason of dirty globes. Next year the globes will be one-quarter frosted.

Articles of incorporation have been filed in Camden, N. J., by the National Gas and Electric Fixture Co., with a capital stock of $500,000, $25,000 paid in. The incorporators include capitalists from this city, New York and New Jersey. Among the Philadelphians interested are Clement M. Biddle, William N. Yeaton and Benjamin Thackara. In reference to the new company one of the latter said yesterday:—"We intend to do a buying and selling business on a large scale. At present we are negotiating for a large plant in Camden. Should we fail to get this plant we will build one of our own."

The rapid increase of electric light wires in Camden has caused the linemen of the South Jersey Telephone Co. to protest against the dangerous proximity of the two sets of wires. They have had several narrow escapes from the contact of wires recently. Superintendent C. A. Janke protested, and the fire commission passed a resolution forbidding the electric light company the use of the telephone company's poles, except under the latter's supervision.

The annual report of the Bell Telephone Co., of this city, for 1889, shows the cost of its lines and equipment to be $610,410.94 of which $142,615.14 was paid out in underground construction. The expenses for the year were $233,630.08, and the receipts, $434,191.97. The company had invested in real estate, $59,924.53, and $236,046.79 in stocks, bonds and other securities. Its entire assets aggregated $1,000,565.52. The amount paid in dividends was $67,200.

Citizens of the Eighth Ward have called attention to the poor quality of the electric light furnished. Chief Walker, of the electrical bureau, said that his department had been making tests, and that a report would be completed showing the result of the measurements. In the specifications for 1890 submitted by Director Wagner, this matter of inferior candle-power will be thoroughly covered. The electric companies will be required to state the candle-power they propose to furnish, and also to agree upon a system of measurements which shall be used in arriving at the quality of their light. These measurements, Mr. Walker said, would give the necessary candle-power. The measurements that the bureau have been making have been very tedious. Ever since last June, a period of nearly seven months, the work has been going on, and mostly after 12 o'clock at night, when the streets are deserted.

Mr. Graham, of city council, said that he had been informed by Director Wagner that next year he would insist that the electrical companies should be paid for their lamps in proportion to the candle-power furnished.

Chief Walker said that there was no such thing as a light of 2,000 c. p. When the Brush company contracts for a light of that power, they always insert in parenthesis the word "nominal."

PHILADELPHIA, January 16, 1890.

BOSTON.

The Cause of the Recent Great Fire not yet Ascertained; Corrected Statement of the Losses.—Experiments Before the Aldermen.—Excitement Over the New City Lighting Contracts.—Citizens and Insurance Men Protest against Duplicating the Present Overhead System of Wires.—The Attitude of the Boston Electric Light Company.—Lectures by Mr. Geo. W. Mansfield.—The New England Electric Exchange.—Output of Telephones.—Electrical Door Openers at the Tremont Theatre.—The Police Signal System.

THE question of the origin of the fire which occurred on Thanksgiving Day has not yet been settled, evidence still being taken. Two weeks will probably elapse before the issue of the report by the fire marshal.

Mr. John C. Paige, a prominent insurance man of this city has made a complete compilation of the losses by the fire. It shows that the loss on real and personal property amounts to $3,784,871, and the loss of the insurance companies to $3,164,836.

The first estimates were based upon the average stock carried by the firms losing, but upon later investigation it appears that the fire occurred between seasons, as it were, when the change in stock was in progress, and develops the fact that most of the firms had but a small stock on hand, hence the loss was not so heavy as the first estimate would indicate.

Some experiments have been tried recently before aldermanic committees to show some of the results of very heavy currents upon telephone instruments and "fuses;" the recent fire bringing forward many contrivances for guarding persons and property from danger. A wire was attached to the dynamo of an arc circuit of the Boston Electric Lighting Co., carrying 46 lights, the voltage being 2,300. A telephone was put into the circuit and the entire current sent through the instrument with the purpose in view of ascertaining whether the telephone could be set on fire in that way. At first smoke was emitted from the box, soon subsiding, however. When the box was opened it was found that the silk covering upon the wire surrounding the coil had been burned off, causing the smoke, and that the wire had melted. The regulator upon the dynamo responding automatically to this condition so reduced the pressure that all danger from that source ceased. The box was not inflamed, nor even charred.

A test was also made of several fuses such as are used by the telephone company.

The test was so successful that whenever the current under 2,300 volts pressure was sent into the wire supplied with a fuse the latter melted at once, thus breaking the current. There had been some expectation that an arc might be formed between the severed ends, thereby renewing the danger, but it was not realized.

The results of these tests raised a strong presumption that electricity was not the cause of the big fire.

The streets are full of talk regarding Mayor Hart's recent action in awarding the contract for the city's electric lights to another company than the Boston Electric Light Co., which has lighted the city for the past half dozen years.

This action will, if carried through, necessitate the erection of a duplicate set of poles and wires; and many petitions of remonstrance have been received at City Hall against this multiplication of the sources of danger already too plentiful.

Mayor Hart recently took a trip through the large cities of the country with a view to ascertaining the ideas of city officials with regard to the overhead wire question, and also to find out the cost of lighting the streets.

Boston has paid 65 cents per night per light for her arc lights, and the mayor considers this price to be exorbitant, finding that none of the cities visited pay over 50 cents. As the contract with the present company expires this year the proposals for lighting were sent in, no proposal over 40 cents to be considered.

The Boston Electric Light Co. made no tender, claiming that they could not light the 800 lights in the city at that rate. In consequence, the contract was awarded to the Suburban Electric Light and Power Co., with the understanding that everything shall be ready in sixteen weeks, at the rate of $39\frac{74}{100}$ cents for Boston, $37\frac{22}{100}$ for Roxbury and 40 cents for Charlestown. The company have expressed their willingness to put the wires underground. While the preparations are being made, however, the Boston Electric Light Co. will supply the lights at the same rate as before.

President Gilbert, of the Boston Electric Light Co., says that the directors of the company will do all in their power to protect the interests of the stockholders.

He had been willing to leave the settlement of a contract price to the decision of the gas commissioners or would consent to an inspection of the company's books by experts provided by the mayor, and abide by the result. If Mayor Hart had removed the restriction of a 40 cent limit he could have put in a bid of 50 cents for certain districts and of a lower rate for other districts, which would have brought the average expense below 50 cents a light per night. It costs the company, he says, 47 cents per light to light the streets of Boston at present.

Insurance men are protesting against the duplication of electric wires, and a petition has been presented to the mayor and aldermen to that effect. They state that they do not want to stand in the way of progress, but they do protest against the construction of four or five hundred miles of wires, carrying a voltage as great as that which has recently caused such a furore in New York, over the streets of the city, merely to save a comparatively small annual sum per year.

Many people have applauded Mayor Hart for his economy; but they do not consider the fact that to save a few thousands they are endangering many millions of dollars worth of valuable property. Both insurance men and property owners are desirous of making the hazard as small as possible, and hence the protest, which reads as follows:—

BOSTON, January 10, 1890.

To His Honor the Mayor and the Board of Aldermen of the City of Boston:

GENTLEMEN:—The undersigned fire underwriters doing business in this city respectfully represent that while it is evident that electricity is to be generally used for light and power, this use is, in the present state of the science, attended with dangers, especially with wires carrying a current of high tension.

It is therefore desirable, for the safety of life and property, that there should be no unnecessary duplication of wires, as this implies an increase of the dangers incident to their use.

For this reason the undersigned feel called upon to protest against the introduction into this city of another electric company running its wires throughout the streets and over the tops of our buildings, as they believe that the slight saving in money which the city would effect by having its streets lighted by this new company would in no way counterbalance the risk which would be run by these added and unnecessary elements of danger.

If it should be decided, in spite of this protest, to allow another electric light company to carry its wires through our streets, it is the hope of your petitioners that it shall be a condition in the contract that the wires put up shall be insulated in the most approved manner, and in other ways arranged to guard against accidents.

The petition is signed by all of the prominent insurance firms in the city,

There have been a good many lectures in this vicinity of late on electrical subjects. Mr. G. W. Mansfield, electrician of the Thomson-Houston Co., gave an interesting one on the 26th, on the subject of "Electrical Railroading."

Early in January Mr. Mansfield lectured upon the use of the electric current as a motive power.

These lectures by Mr. Mansfield are exceedingly interesting and instructive. It is an excellent plan to place before the public the correct theory and practice of these electrical applications, thus tending to set aside (in a great measure) the silly fear, born of ignorance, with regard to electric cars. There are people in this city to-day who will wait a quarter of an hour to take a horse car, rather than get "shocked" in the electric one.

The quarterly meeting of the New England Electric Exchange was held on January 13th in the rooms of the Boston Electric Club, President Alexander in the chair. The matter discussed at greatest length was that of providing examiners of applicants for licenses.

Mr. Frank Ridlon, for the committee on examiners, reported that it was no easy matter to procure examiners, and said the only thing to be done was to hire competent experts and create a board of two with the possibility of calling in a third.

This caused a long discussion, resulting in the passage of two votes. The first to continue the committee with instructions to report to the executive committee the best way to obtain a permanent examiner. The second vote empowered the board of directors to take such action as it may deem proper to secure an examiner.

Mr. Spalding reported that the committee on instruction had made no progress on account of lack of time. Mr. Ridlon said that his idea was to print a set of rules for circulation amongst teamsters and policemen, setting forth the proper course of action in case they should meet with broken wires.

The statement of the output of telephones by the American Bell company for the month and year ended December 21, with comparisons, is as follows:—

	1889.	1888.		
December:—				
Gross	5,010	3,948	Inc.	1,062
Returned	2.140	2,163	Dec.	23
Net	2,870	1,785	Inc.	1,085
Year:—				
Gross	57,167	53,609	Inc.	3,558
Returned	24,967	23,601	Inc.	1,366
Net	32,200	30,008	Inc.	2,192

The electric doors of the Tremont Theatre are now in readiness for use. No other theatre in this or any other country (except the Broadway, New York) has such a safeguard and convenience. By simply touching a button in any of eight handy places in the theatre, seventeen sets of folding doors to as many exits fly open immediately. The expense attending the furnishing of these doors is a hundred times repaid by the safety felt by the theatre's patrons.

The number of police signal boxes in Boston now is 411; miles of wire, 213.5; average cost per mile, $99.10. There are in the service 9 wagons and 19 horses, with one wagon and two horses in the repair department. During the year the wagons made 23,621 runs, covering 15,089 miles; 24,374 prisoners and 780 lost children were taken to the station house, and 692 injured and insane persons to the station house or elsewhere.

BOSTON, January 18, 1889.

CHICAGO.

The Chicago Electric Club to Entertain Eastern Delegates to the Electric Light Convention on Their Way to Kansas City.—Overhead Wire Privileges.—The Illinois Electric Light Association Organized.—A Suit Touching the Rights and Privileges of Telegraph Employes.—A Thomson-Houston Electric Motor Rescues a Printing Office from Serious Loss.—Electric Club Notes.—The Chicago Telephone Co. and the City Departments.—New Incorporations.—Personal Notes.--Suspension of Telegraph Service and Board of Trade Operations by the Storm of January 12.--Edison Isolated Plants of Large Size.

THE Chicago Electric Club proposes to entertain the eastern delegates to the Kansas City Convention of the National Electric Light Association, *en route* on the "electric limited," February 10. The board of managers instructed W. A. Kreidler, secretary of the club, to extend the invitation, which has been accepted by Secretary Garratt, of the Electric Light Association. The Chicago Electric Club has appointed the following committee of arrangements for the entertainment of its guests:—W. A. Kreidler, chairman; F. E. Degenhardt, Alex. Kempt, F. G. Beach and F. B. Badt.

The question of overhead wires is vexing Chicago. Before the annexation of several suburban towns and cities last spring, the local authorities had passed ordinances giving to several companies the right to string overhead wires. These franchises, though accepted, had not been utilized when the suburbs concerned were annexed. It is now the fixed policy of the Chicago authorities to refuse permission to any company to put up aerial circuits. A few weeks ago the Lake View Electric Light Co. decided to avail itself of its franchise, and, therefore, applied to Commissioner Purdy to issue a permit, enabling it to commence work. He refused at first, and referred the matter to the legal department of the city. A decision was given, stating that the ordinance was valid, inasmuch as the Supreme Court had held that annexation did not affect ordinances granted by municipalities before the incorporation of annexed districts. The commissioner thereupon issued the permit. The case is interesting, as several companies held similar franchises, granted by Hyde Park and the Town of Lake, before they were annexed. The companies which hold these franchises maintain that it would be exceedingly unjust if their franchises were made null and void, simply because the towns in which they secured privileges have been swallowed up by a larger municipality. In behalf of companies which have been operating in Chicago it is said, on the other hand, that it seems exceedingly unjust to allow a new company to string overhead wires while such a privilege is rigidly withheld from them. Professor Barrett, the city electrician, is firmly opposed to overhead wires anywhere within the city limits.

Representatives of Illinois central station companies met at the rooms of the Chicago Electric Club, January 18, and organized the Illinois Electric Lighting Association. Mr. Allen R. Foote, chairman of the Committee on State and Municipal Legislation of the National Electric Light Association, summarized the benefits to be derived from the organization of a state association. He said this was the seventh state organization formed under the plan of the National Electric Light Association. The following temporary officers were elected:—President, C. H. Wilmerding, Chicago; first vice-president, A. L. Ide, Springfield; second vice-president, Douglas Hopeman, Ottawa; secretary and treasurer, Charles E. Gregory, Chicago; executive committee, Charles I. Page, Englewood, and M. B. Beal, Rockford.

During the early part of January, Mr. Frederick H. Tubbs, superintendent of the Western Union Chicago office, appeared before Judge Tuthill in response to a citation, requiring him to show why he should not answer questions asked by a commissioner appointed by a Kansas City court to take take testimony in a suit of Edward L. Randall against the Chicago, Rock Island & Pacific Railroad Co. The suit is one that has a particular interest to telegraph operators, and has been pending for some time. The plaintiff seeks to secure $25,000 damages. He was a telegraph operator for the company at Davenport, Ia., but was discharged in 1886, because, as he alleges, he was active in organizing a branch of the Order of Railway Telegraph Operators. After his discharge, it is alleged, he was "black-listed," and a secret circular was sent out stating the fact. When Randall came to Chicago he was refused work in consequence, as he asserts, of the circular. Mr. Tubbs was summoned before the commissioner appointed to take testimony in Chicago, and was asked questions concerning the circular. To several of these queries he refused to reply. He was then summoned to show cause why he should not give answers. Judge Tuthill decided that Mr. Tubbs must reply. He thought the rule of privileged communications could not hold in this case. Randall was not an employé of the Western Union, and it was stretching the rule a great deal, the court thought, to say it applied because Randall might become an employé of the company at some time.

Early in January a boiler in the basement of the building occupied by the John Morris Printing Co., Chicago, exploded. Several persons were seriously hurt and one employé was killed. The owners of the printing office anticipated a serious loss from the stoppage of work caused by the wreck of their steam plant. A 40 h. p. Thomson-Houston electric motor was installed and connected to the Edison circuit. The explosion occurred on Friday, but, as a result of the employment of the electric motor, the printing company was able to run its plant as usual on the following Monday.

At the meeting of the Chicago Electric Club, January 6, Professor Louis Bell read a paper on "The Theory of Compounding Dynamos for Constant Potential." At the club meeting, January 20, Mr. Foree Bain read an interesting paper on "Experience as a Teacher in Electrical Engineering." The writer of the paper described a number of simple but ingenious means which he had devised for accomplishing practical electrical results. His lecture was fully illustrated, and was extremely interesting and practical.

The Chicago Telephone Co. has removed its telephones from the city building and the police stations throughout the city. When the city council passed an ordinance taxing the company, it felt that it was relieved by that act from furnishing free telephone service to the city. The council will probably make an appropriation for telephones.

Belvidere, Ill., is to have an electric light plant. The central station will be equipped with Westinghouse alternating dynamos, with a capacity of 750 lights.

The Naperville, Ill., Electric Light Co. has been incorporated with a capital stock of $12,000.

The Minonk, Ill., Electric Light and Power Co. has been incorporated with a capital stock of $15,000, by M. L. Newell, A. B. Knipp and G. W. Weber.

The Macomb Electric Light and Gas Co., of Macomb, Ill., has been formed with a capital stock of $25,000. The incorporators are Charles Ketteron, H. W. Cummings and J. N. Rume.

Mr. F. G. Beach, president of the Chicago Electric Club, was seriously ill early in the month, but has now entirely recovered.

Mr. Allen R. Foote, who has charge of the department of electricity for the eleventh census, was in Chicago January 20.

Mr. H. Ward Leonard, of the United Edison Co., New York, attended the meeting of the Chicago Electric Club, January 20.

The Board of Trade practically suspended operations on January 13, as the storm of the preceding evening had worked havoc with all wires entering the city.

The Chicago Edison Co. recently installed an incandescent plant in the Windsor Theatre in Chicago. The house is wired for 900 lights. The plant consists of two Edison compound dynamos and a 90 h. p. Russell engine. The Edison company has also installed a 250-light plant at the salesrooms of Lyon, Potter & Co.

CHICAGO, January 22, 1890.

ST. LOUIS.

The Public Lighting; the System Partially Started January 1.—Telephone Service Disturbed.—Consolidation and Reorganization of Lighting and Power Companies.—The Western Union Telegraph Office Burned Out.—Great Damage to Electric Wires from the Sleet Storm of January 6-7 and the Cyclone of January 12.; Prompt Restoration of Service.--Electric Traction.--Corporation Notes.—A New Gas Scheme.

ST. LOUIS being the first city to undertake a complete illumination of streets, alleys, parks and city buildings by electric lights, its progress is no doubt watched with interest by other cities as well as by the electrical trade interests. The Municipal Electric Light and Power Co. were not prepared to begin their part of the service January 1. The Missouri Electric Light and Power Co. and the Laclede Gas Co., contractors for the incandescent lighting of the alleys, parks and city buildings were ready, and at 8 o'clock P. M., December 31st, the lights were formally turned on by the daughter of Mayor Noonan.

So far as the lights are concerned everything is successful. The alley lighting is especially satisfactory to every one, and particularly so to the police authorities. But so far as the telephone service is concerned the matter is not so satisfactory. In the southern part of the city, the territory covered by the Missouri Electric Light and Power Co., the telephone service was almost annihilated by induction from their Westinghouse alternating currents. Trial runs some days previous had indicated this result. The Bell Telephone Co. would not put up with the disturbance, and threatened an injunction. The electric light company claimed that the trouble was caused in some way by "dead" wires; while the telephone company claim that the induction is due to an unbalanced condition on the two parallel electric light main conductors. The mayor ordered both companies to discontinue their lights until the disturbance could be abated. The supervisor of city lighting was instructed to remove all "dead" wires. The electric lighting companies voluntarily aided in this work, furnishing men and teams. In the northern part of the city—the Laclede Gas Co. territory—this clearing out of "dead" wires was followed by such a diminution of the disturbance that in a few days the service of the electric lights was permitted to be resumed. But in the Missouri company's territory the situation was but slightly improved, and they are now adjusting their circuits so as to produce a better balance of the outgoing and incoming circuits. The rules of the board of public improvements covering this case are as follows:—"The two electric light wires of each metallic circuit shall occupy the same cross-arm on each pole, and shall run parallel to each other not more than one foot apart along the entire route of the circuit." It seems that the Missouri company have not fully executed the provisions of this rule, at least the telephone company so claim.

Aside from the telephone troubles there were a few cases of persons being slightly shocked by coming in contact with "dead" wires. The state of the weather was very unfavorable. During the first week of the month there prevailed an almost continuous slow rain, which finally terminated in a heavy sleet storm. Under these circumstances and the fact that much of the wire construction had been unduly hurried, and in some cases left in an unfinished state, it is not surprising that some slight mishap should occur.

The mayor has ordered the supervisor of city lighting to enforce the proper erection of all private wires and the removal of all wires as soon as they become useless.

A joint committee of the two branches of the city legislature has been appointed with authority to investigate the "dead" wire question. With these investigations and proper precautions a satisfactory solution of all trouble is confidently expected.

On December 30th, 1889, the St. Louis Illuminating Co. increased their capital stock from $100,000 to $500,000. They have absorbed the United Electric Light and Power Co. on the following basis:—paying in bonds $326,000 to the United Electric Light and Power Co., $125,000 to the St. Louis Illuminating Co., while the balance, $49,000 will be held in the treasury. The reorganization of the St. Louis Illuminating Co. was effected on January 4, 1890, and resulted as follows:—Jas. Campbell, president; J. D. Thompson, vice-president; C. S. Horton, secretary and treasurer; directors, Jas. J. Davis, Alex. Ross and Henry W. Bond. Messrs. Thompson, Ross and Bond represent the Hollins syndicate, and Jas. J. Davis represents Philadelphia interests, presumably the United Gas Improvement Co.; Jas. Campbell represents his individual interests.

On January 6th the St. Louis Illuminating Co. filed a deed of trust for $500,000 in favor of the Atlantic Trust Co. to secure the issue of $500,000 in 6 per cent. 20 year bonds, which are to be distributed as stated above.

At about six o'clock Wednesday morning, January 8th, the head-quarters and main office of the W. U. Telegraph Co., corner of Third and Olive streets, was destroyed by fire. The fire originated in the basement and spread upward to the operating room on the fourth floor with great rapidity. The few operators on duty escaped hurriedly. Very little apparatus was saved. The fire department responded promptly, but the flames had made such headway before the alarm was turned on that they labored at great disadvantage, and could not suppress the fire until it had reached the roof and had destroyed the east cupola and the main switch-board. The loss is variously estimated at $8,000 to $10,000.

The telegraph officials claim that the fire originated from an electric light wire; but this is denied by the United Electric Light officials who investigated the case.

Temporary quarters were taken at 215 Pine street, and a car load of material was ordered from Chicago, which arrived during the following night. Two 40-wire cables were strung from the west cupola—which had escaped injury—across Olive street and the housetops of the intervening block to their temporary quarters. On the following morning, January 9th, the staff were ready for business, having established a Wheatstone circuit to Kansas City, to which point all business was sent for distribution.

On the night of January 6th–7th a heavy sleet storm occurred, which did great damage to all electric wires. The Bell Telephone Co., of Missouri, had 450 wires broken. The Western Union Telegraph Co. and the City Telegraph and Telephone Service suffered heavily.

On Tuesday morning, January 7th, two horses of the People's Street Car Line were killed by a fallen electric light wire on Fourth street, between Market and Chestnut. The heavy sleet storm was the cause of the falling of the wire.

At 4.30 P. M. Sunday, January 12th, a cyclone of considerable force passed through the city in a south-easterly direction, doing much damage to all electric wires. The Bell Telephone Co. had 656 wires broken. Their repairing forces were put to work immediately after the cyclone, and by the aid of calcium lights their work was continued all night, and all breaks were repaired in 24 hours.

The Laclede Gas Co. also made immediate repairs to their circuits and were ready for their night's lighting. The Missouri company being shut off from their public lighting by order of the supervisor of city lighting, attended to their commercial service only.

On February 13th the Missouri Railroad Co. will vote upon a proposition to increase their capital stock from $800,000 to $2,400,000. The object of this increase in capital is to change the motive power on their Market street and Forest Park lines, and also to take up $500,000 of their 6 per cent. 5-20 optional bonds, and repay $100,000 cash which was borrowed to complete their Olive street cable equipment about a year ago. Electric street car propulsion has made such satisfactory progress in St. Louis since they adopted the cable on their Olive street line that they are contemplating the adoption of electric power in the reconstruction of the two lines mentioned above.

At an annual election of the Missouri Electric Light and Power Co. on January 14th, the following directors were elected for the year 1890:—S. M. Dodd, J. Clifford Richardson, J. C. Van Blarcomb, Jas. W. Bell, Edward Whittaker, Thos. H. West and R. C. Kerenes.

On account of expiration of charter the St. Louis Gas Light Co. sold their entire property and rights at public sale on December 24, 1889. The Laclede Gas Light Co. was the only bidder at $4,000,000. This places the Laclede company in control of the gas business of the entire city.

The gas industry seems to have much vitality, for notwithstanding the above a new gas scheme is being brought forward; the promoters claiming that by a new process they can sell gas for heating purposes at .45 cents per thousand, and .75 cents for illuminating purposes. A bill has been introduced before the city legislature asking for a franchise. The title of the scheme is, Metropolitan Electric Light and Gas Fuel Co. of Missouri, from which it seems that they intend to enter the illuminating field at large and fight the enemy (the Laclede company) on their own ground.

The Laclede company claim that their patent—the Brazelle patent—is an infringement on patents owned by them and they are therefore, they say, not alarmed in the least by the new scheme. Be this as it may the city legislature and the public-spirited citizens are giving the new gas scheme due consideration.

St. Louis, January 18th, 1890.

PITTSBURGH.

A Superb Fire Alarm Switch-Board.—Electric Cars Started on the Pleasant Valley Road.—An Important Consolidation.—Progress of the Cable Road of the Central Traction Co.—Success of the Tesla Motor with Mining Machinery.—Extension of Business and Increase of Capital Stock by the Allegheny Light Co.—Col. Love and a Big Railway Scheme.

The City Hall is about to be graced with the costliest switch-board, in connection with the operation of the city fire-alarm system, in the whole country. The apparatus is to cost no less than $9,135. Its frame-work is of light colored mahogany. The sides and the panel are covered with artistic carvings and the entire aspect of the apparatus is extremely handsome. There is not a piece of iron employed in it; everything being steel, brass, copper and german silver. All the latest improvements in fire alarm apparatus have been embodied in this outfit, and experts who have examined the details pronounce the entire arrangement as nearly perfect as possible. Mr. Morris Mead is the superintendent of the bureau of electricity in this city, and he is very proud of this new accession to his department.

The contract for the apparatus has been accorded to the Gamewell Fire-Alarm Co. of New York.

On Saturday, January the 17th, the Pleasant Valley Electric Railway commenced operations, and as the cars sped along through the streets of Pittsburgh and Allegheny they created quite an excitement among pedestrians. The Pleasant Valley Co. is operated with the Sprague electric motor and overhead wire system.

The question of overhead wires appears to be in a dormant state in this city since Chief Bigelow of the department of public works has stated that all the wires have to be underground within the coming year.

An important electrical consolidation has been effected here. At a meeting of the stockholders of the Keystone Construction Co., the Marr Construction Co. and the Washington Carbon Co. the interests of these various concerns were merged into the North American Construction Co. The new organization went into effect Tuesday, January 21. The offices of the company will be in the Westinghouse building in this city.

The officers of the new company are J. S. Humbird, president; F. S. Marr, vice-president and general manager; H. M. Doubleday, assistant general manager, and E. H. Wells, general agent. The company employs about 400 men to do the exploiting and constructing of central station plants and street railway construction of the Westinghouse Electric Co., and also build, lease and operate central stations. The capital stock is $500,000.

The cables and the cars of the newly-built Central Traction Co.'s street car line from Wood street, Pittsburgh to Minersville have arrived here. The machinery in the power house is expected to be put up within a week and the road, will be running by February 1.

Special officer Dierst, of the Southside police department received an electric shock from a grounded wire a few days ago, and for a few moments he gave a free exhibition of jig dancing in a public thoroughfare. He was not hurt, however.

The Hercules Mining Machine Co., of this city, has for the past two years experimented with a new machine for use in coal mines. Mr. John H. Scully, of the Diamond National Bank of this city, is the president of the company. A number of tests were made to obtain a suitable motive power for the operation of the machine. Compressed air and other energies failed to operate successfully until the company tried the Tesla motor of the Westinghouse Electric Co., and now the machine is proving a great success. A considerable number of the machines with Tesla motors are being introduced in the mines of the Monongahela Gas Coal Co., and it is thought that all the mines along the Monongahela will eventually adopt them, because the machine has the great advantage of getting out coal at the lowest cost.

The stockholders of the Allegheny County Light Co. held a special meeting on January 4th to discuss the advisability of increasing the capital stock of the company. It was decided to increase the capital from $500,000 to $1,250,000. This company operates now a very large plant in this city, with the Westinghouse alternating current system. The arc light plant consists of machinery for 800 arc lights, and the incandescent plant has a capacity of nearly 30,000 incandescent lamps. The plant is situated on Virgin alley in the heart of the city, and on account of the rapidity of its extension the place is getting too small. For that reason it is thought necessary to remove the plant to a more suitable locality, where buildings are to be erected which will admit of sufficient machinery for a capacity of 100,000 incandescent lamps. The new building is to be erected at the cost of $500,000.

Mr. Love, of Philadelphia, who appeared in this city sometime ago, and told in several interviews with the reporters of the daily papers of a system of electric street car motors, is now said to be interested in the organization of a gigantic electric railroad scheme in this city. The scheme is said to be backed by Boston capitalists with a capital of $21,000,000. The idea is to build an elevated road above the highest buildings, to run from the Exposition Building in this city to East Liberty, a distance of five miles. There are to be several stations along the line, which are to be reached by rapid elevators. The transit on this road is to be accomplished within one-fourth of the time of the cable road, which means that the whole distance will be covered within seven minutes. A charter is sought by the gentlemen interested, whose names are not given at present; they are getting into shape to carry their plans into effect.

PITTSBURGH, January 20, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE LAW OF INVERSE SQUARE.

[116.]—In the January number of the ELECTRICAL ENGINEER, letter No. 112, page 27, I observe a comment by Mr. Harry Fielding Reid on my article which appeared in November.

The article was not written for the instruction of persons already familiar with the meaning of the equation of Laplace, nor under the impression that I had made any new discovery.

If I have inverted Laplace's reasoning I still do not see that I am "begging the question," unless I have first used the same without inversion, which, so far as I can see, I have not done.

When investigators were endeavoring to establish the conservation of energy they advanced in its support arguments based on the impossibility of the perpetual motion, which in turn is an induction from numberless experiments. Now, although all, of at least a vast majority of the scientific world, believe in the conservation of energy, the reasoning is sometimes inverted, and the impossibility of the perpetual motion becomes a deduction from the conservation of energy.

Of course, this is begging the question, if there be not sufficient evidence for the conservation of energy without the perpetual motion argument.

Assume a closed surface around a centre of force, the surface integral over the whole surface being finite and positive.

This is consistent with the assumption that the law is any function of the distance. Now, suppose this closed surface, divided into two compartments by another surface, one compartment containing the centre of force and the other being, of course, vacant. Next take the surface integral over each compartment separately.

That over the compartment containing the centre of force will in general be finite, though not necessarily equal to that over the original surface, unless the law of force be that of the inverse square.

Let us suppose it is less. Then the surface integral over the vacant compartment has a positive finite value. This, to my mind at least, is contrary to the concept of a central force. This finite positive quantity of force must either come from nowhere in particular, or else it must come from one or more definite points (centres of force) within the so-called vacant compartment.

If Mr. Reid can show that a central force is not necessarily traceable to a definite origin, or, on the other hand, that there may be definite points at which forces originate, and from which they emanate (or radiate, if he prefer the word), but which are not centres of force, then, of course, the argument of my article falls to the ground. It seems to me a part of the concept of central forces that any point capable of increasing a surface integral by incision within the surface is a centre of force. In proving the parallelogram of forces it is customary to suppose a force or pressure which is applied at one end of a line and in the direction of the line, to be transferred without gain or loss or change of direction to the other end of the line.

Is there an independent assumption in substituting for the straight line an elementary straight tube of force? If not, then the law of inverse square is true, for the case where the lines of force are straight, and by the compounding of the forces from an infinite number of elements of volume for which these lines of force are straight, we find that the force at any section of an elementary curved tube of force may be conceived to be transferred to any other section of the tube without gain or loss or change of direction, other than that which the tube undergoes at the same time.

My remarks on Maxwell's experiment, of course, stand or fall according to the truth or error of the rest of the article.

TOWNSEND WOLCOTT.
851 Greene Ave., Brooklyn, N. Y.

CRITICISM OF DEWEY'S CATALOGUING SYSTEM.

[117.]—I would like to call the attention of engineers, especially electrical engineers, to the treatment of *Engineering* in Mr. Dewey's system of cataloguing libraries. His system has much general merit, and is going into use largely in public and college libraries. It is important that errors in any part of it should be condemned by those interested, and corrected.

The whole subject of engineering runs from 620 to 629 inclusive. Thus:—

620 ENGINEERING.
  621 *Mechanical Engineering.*
  621.1 Steam Engineering.
    .2 Water Engines.
    .3 Electrical Engineering.
    .4 Air and Gas Engines
    .5 Air Compressors.
    .6 Blowing and Pumping Engines.
    .7 Mills and Manufacturing.
    .8 Mill Work and Mechanism of Transmission.
    .9 Machine Tools.
  622 *Mining Engineering.*
  [The tenths are given to subdivisions as under 621.]
  623 *Military and Naval Engineering.*
  624 *Bridges and Roofs.*
  625 *Railroad and Road Engineering.*
  626 *Canal Engineering.*
  627 *River, Harbor and General Hydraulic Engineering.*
  628 *Sanitary Engineering, Water Works.*
  629 *Other Branches of Engineering.*

Several things are remarkable in this scheme.

One is the entire absence of *Civil Engineering* as one of the co-ordinate main divisions.

Another is the putting of some of the subdivisions of civil engineering in a co-ordinate rank with 'mechanical, mining and other chief divisions of engineering.

A third is that the only recognition that there is such a thing as *Electrical Engineering* is that it is tucked in as one of the numerous subdivisions of one of the divisions [Mechanical Engineering].

This is pretty small for a line of engineering work which, from the numbers it employs, the brains it requires, the extent of specific and peculiar knowledge demanded, the provisions made for it in leading universities and technical schools, the amount of capital invested in it, its multitudinous and almost universal use, and the unlimited field it has entered upon with assurance of unparalleled growth, should certainly rank as one of the co-ordinate first divisions of the general subject, Engineering.

Will not those interested in the various departments of engineering endeavor to have Mr. Dewey revise this? Write to him. He is librarian of the State Library, Albany, New York. Express your views in any publication. Do what you can to prevent any library from following this decidedly faulty arrangement of books on its shelves and in its catalogue.

To remedy one or two great faults, let any number of the divisions 624 to 628 be put together as *Civil Engineering*, and let one of the numbers of main divisions thus freed be given to *Electrical Engineering*.

I. THORNTON OSMOND.

State College, Pennsylvania, Jan. 13, 1890.

LITERATURE.

Papers on Alternating Currents of Electricity for the Use of Students and Engineers. By T. H. BLAKESLEY, A. M. London: *Whittaker & Co.;* New York: *D. Van Nostrand Company.*

IN the first edition of these papers geometrical methods of dealing with problems relating to alternating currents were first clearly presented in accessible form for the general student. When these articles first appeared in the electrical journals it was undoubtedly a revelation to most students that harmonically varying electromotive forces could be compounded by the old well-known polygon of forces. No matter how many electromotive forces there might be, so long as they had the same period it was possible, if the problem was determinate at all, to solve it by a geometrical construction. Alternating current generators, motors and converters were studied by this method. The ease with which many of the most difficult problems can be solved is an important advantage; but it is not in this alone that the value of the method is found. It represents to the eye the exact relations of the electromotive forces and currents, and shows at a glance what results would follow the change of one component or another.

In the second edition are given the applications of the method to the study of condensers used with alternating currents, and of condenser transformers. A very interesting result is reached on page 51, where it is shown that a condenser with self-induction may, for a certain frequency of alternation, operate exactly as a closed circuit without self-induction.

The chapter on the condenser transformer shows well the conditions that must obtain for the successful use of condensers as transformers. It is not very encouraging as to their practical use in place of the dynamic induction transformers now employed.

The chapter on transmission of power is, perhaps, the most important. Here the whole subject of the behavior of two sources of alternating E. M. F. is discussed, and it is here that the advantages and great simplicity of the graphical method are most apparent. A simple geometrical diagram is made to show all the conditions of stability and instability for two connected sources of alternating currents. The author points out that it is possible for two alternating dynamos to run in series, and both do work, in case not enough power is supplied to either of them to do all the work demanded on the circuit.

In assuming the first case, of two machines coupled together, the author says: "Let us suppose a case where the sources are two in number, represented in magnitude and phase by A B, B C (fig. 19), of which B C is the smaller;" and in the subsequent discussion, the reader is led to suppose that only B C may become a motor, but it plainly appears from the figure that under certain conditions—for certain values of self-induction—it is possible for the source of greater E. M. F. to become the receiver and run in stable equilibrium as a motor. This is pointed out in the addendum to the chapter, on page 96.

The book is a very valuable contribution to the literature of alternating currents; and those who have to do with the designing of alternating current apparatus will find ready at hand the solution of many problems, and suggestions that will lead to the ready solution of almost any problem that may arise.

Practical Notes for Electrical Students. By A. E. KENNELLY and H. D. WILKINSON. The Electrician Printing and Publishing Co., London, 1890.

IN this work, the first volume of which has just appeared, will be found many matters of interest and value to the readers for whom it is intended. Those parts of the book which deal with practical details are, as the title would lead us to expect, the most important. Considerable space is, however, devoted to the statement of some of the elementary principles of the science. In the performance of this portion of their task the authors have hampered themselves by the determination, which they have announced in the preface, "to exclude all mathematical expressions and endeavor to put into words anything expressing a relation between quantities."

A good example of the disadvantage of such a method may be found in the statement of Ohm's law on pages 38 and 39.

This tendency is occasionally carried so far as to lead to the avoidance of a precise statement, even when such a statement involves no difficulty whatever. Few readers, we think, who wish to know what an ohm is, and seek for information on that subject on page 10, will be so well satisfied by being told that "an ohm is, roughly, the resistance offered by a column of mercury one meter long and one square millimeter in section," as they would have been by the equally simple statement of the exact length of the mercury column.

The work is nevertheless characterized throughout by clearness and conciseness of statement. The chapter devoted to galvanic cells is especially good; and the description of vertical current indicators will prove of value to many readers who have already acquired considerable practical knowledge of electricity. The omission of the voltameter as a means of calibration, and the failure to include mirror galvanometers in the discussion of indicators of current, would be a subject of comment in considering any completed work of this kind; but these and many other important topics, which have not found place in the volume before us, will doubtless receive their due share of attention in that portion of the series of "Notes," which is yet to appear.

By far, the most valuable portion of the present volume is that which is devoted to the study of the magnetic field. In this last and ninth chapter, which considerably exceeds in length the entire preceding portion of the book, many of the simpler algebraical formulæ are introduced, and the C. G. S. system of units makes its appearance. While the first eight chapters are written in a style which will render them chiefly useful to the beginner, chapter nine, in addition to a very excellent exposition of the well-worn facts in the domain of magnetism, embodies a summary of many important researches which have not yet found their way into our text-books. The pages devoted to Hughes's theory of magnetism, to Fleming's work on hysteresis, and to susceptibility and permeability, indeed, a large part of the chapter, will find many appreciative readers, even among those to whom most of the contents of the earlier chapters may be a very old story.

Die Elektrische Beleuchtung und ihre Anwendung in der Praxis. Verfasst von DR. ALFRED V. URBANITZKY. Wien, Pest, Leipzig: *A. Hartleben's Verlag.*

THIS little book is a fairly good exposition for the lay reader of the principles and instruments used in electric lighting. The last sentence in the book indicates, as well as anything can, the author's intention,—"We conclude the preceding work with the desire that it may assist in extending electro-technical knowledge, and may win many friends for the electric light." To the uninitiated it gives concisely, and for the most part clearly, some definite information regarding a subject generally vaguely apprehended. Perhaps none of the forces employed in modern civilization are met with such bewildered confidence in their possibilities as this same electricity. The reading of just such books as this of Urbanitzky, will do much to instruct the wondering public as to the real action of the electric current and the limitation of electric lighting. The book suffers in places from the failure of the expert to appreciate the exact difficulties which beset the way of the general reader; but the author, for the most part, understands his readers, and makes the path smooth.

The short historical sketch with which the book begins, gives a good idea of the development in the construction of both arc and incandescent lamps. The place in the book given to this sketch is poorly chosen. The lay reader does not understand the nature of the difficulties there described as overcome. If the chapter followed the detailed descriptions of the modern lamps, it would be more satisfactory.

To explain in one chapter the construction of the dynamo, and illustrate by several examples its principal types, seems a hazardous undertaking, but it is justified by the success which the author has attained. The whole section on "electrical machines" is characterized by a wise selection of the essentials to be explained and an equally wise omission of details unimportant to a fair understanding of the subject. The reader is brought directly to the fundamental principle of the dynamo, and by careful reading will get a good idea of the way an electric current is generated; and that, too, without having to form the conception of "field of force." Naturally, the subjects of "secondary batteries" and "converters" receive brief mention before the detailed description of the lamps and their accessories.

The account of the construction of the incandescent lamp lacks a little in interest, but is fairly complete. The arc light, however, is royally treated, and is made to appear in a large variety of forms. The descriptions appear to be accurate and painstaking. Chapter five treats of the accessories to electric lighting. Motive power, the relative merits of the continuous and alternating current systems, regulation of the current, cut-outs, ammeters, voltmeters, measuring and registering apparatus, etc., are here given some attention. The author closes with a brief account of some of the numerous ways in which the electric light can be used. It can be used, he suggests, by the manufacturer and the stage manager, the hotel keeper and the scientist, the railroad corporation and the oculist, and naively concludes: "And so we could enumerate and describe a much longer list of the uses of the electric light, and yet never reach the end."

We cheerfully recommend the book to those whose ideas are hazy regarding the source of the electric light, or the construction and operation of the lamp, believing that a careful reading will do much towards giving them a clear mental vision on this matter.

Notes.

MR. F. B. BADT, in his letter printed in the ELECTRICAL ENGINEER of January touching our review of his "Incandescent Wiring Hand-Book" in December, says: "In the first place my formula is not more complicated than his (the reviewer's), if you eliminate the constant and simply write the formula, $d^2 = N \times D \times K$." Unfortunately it is useless to write the formula in this way, because the factor K is itself merely a symbol for the complicated expression objected to; and as its value must be independently calculated in each case, it might as well be fully expressed at once. Again, even admitting its simplicity, Mr. Badt would still object to the simpler formula on the ground that commercially the allowable loss of potential is usually expressed in percentages of the normal potential and not in volts. But the review nowhere stated that the loss of potential should be specified in volts, except in the formula in order to make the expression more simple; and, moreover, as a matter of fact, even Mr. Badt's formula really reduces percentages to volts lost at last.

As it will be generally conceded that even "practical electricians" or wire men, as distinguished from "office electricians" by Mr. Badt, whatever the difference may be, are likely to know that 10 per cent. of 100 volts is 10 volts, or that 10 per cent of 60 volts is 6 volts, etc., it is evident that this objection must likewise be dismissed.

There was, of course, no intention to disparage Mr. Badt's desire to elevate the standard of the ordinary wire-man; on the contrary it was commended, and the fact that his formula could be stated in a simpler form was suggested as an aid to his object. He has looked at the criticism from the wrong point of view, and he should have decided the question on the merits of the case, and not uphold the complicated formula because it may now be found in extensive use.

RECENT PUBLICATIONS.

Absolute Measurements in Electricity and Magnetism, by Andrew Gray, M. A., F. R. S. E. Second edition, revised and greatly enlarged. London and New York: *Macmillan & Co.*, 1889. 16mo., cloth. 384 pp., illustrated. Price, $1.25.

Traité Élémentaire de L'Énergie Électrique, par E. Hospitalier. Tome premier, avec 253 figures dans le texte. Paris: *G. Masson*, 1890. 8vo, 608 pp.

NEWS AND NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

MEETING OF JANUARY 21, 1890.

The January meeting of the American Institute of Electrical Engineers was held on the evening of the 21st, in the new library and session room at the house of the American Society of Civil Engineers, Mr. George M. Phelps in the chair.

In opening the meeting the chairman made a brief report for the committee appointed at the last meeting to secure and present to the Society of Civil Engineers some contribution to the furniture of their new session room. The committee, he said, had met with cordial support from members of the Institute; and in selecting a modest New Year's gift to the Civil Engineers they had been guided by considerations of utility. The andirons and fire tools on the hearth were the result. They seemed appropriate and useful, inasmuch as the discussions of technical bodies, such as the Civil and the Electrical Engineers, were invariably characterized by coolness, not to say frigidity—it was reserved for Doctors of Divinity and Doctors of Medicine to develop heat in discussion—and a help toward keeping warm was therefore selected.

Professor Anthony then read a paper on "A Review of Modern Electrical Theories." (See page 43.)

The Chairman—Professor Anthony has very pleasantly led us into a realm of etherial speculation—not altogether speculation, because founded on many things known before—and I am quite sure that some of you will be glad to follow him immediately in his excursion through that vast entanglement of wheels.

DISCUSSION.

Dr. Otto A. Moses—Professor Anthony has indeed set our thoughts moving.

I presume that all of us here have been very deeply interested in those speculations, because though they may be speculations, they are the scaffolding upon which the whole science of electricity has been based. It was the pursuit of a hypothesis that led Kepler year after year through very patient investigations to the results which revolutionized astronomy. The same course led Faraday, step by step, to those determinations which culminated in what we are now first recognizing—the identity of electricity and light. So that I can say that we have all been gradually accustoming ourselves to these speculations, even though many of us are engaged in the practical uses of electricity. There are some of Professor Anthony's observations to which I would call particular attention, more especially the last, as bearing upon our practical applications. He spoke of the possibility of using the molecular action of gases as a means of transforming wave-lengths. That, I think, has been done ever since the Rhumkorff coil has been used and the Geissler tube has become so perfect an analyzer of the electric current. In that respect we have already anticipated some of these results. Let us consider what we already have. In the Geissler tube we have the attenuated gases; two disconnected poles; a current passing; and the wave-lengths broken up and the light produced. Whether we can utilize the Geissler tube to effect these immense economies that Professor Anthony so pleasantly prophesied is a question. It has been experimented upon. I have found in my short experience in life that these things come when they are needed. There are groups of ideas that must be exhausted before people will adopt others and investigate them. We have seen it in the development of all branches of electric appliances. In the telegraph, for instance, we have seen Morse using Wheatstone's method of transmission and abandoning it. We saw him commence with underground conductors and abandon them, simply because the art of that day was not perfect enough to allow him to apply them with profit. We can unearth many a theory now which has long existed, but awaited the development of the arts to be put into practice.

I would like to add a brief supplement to Professor Anthony's predictions; in no critical spirit, although I shall be running somewhat counter to the mechanical hypothesis upon which he developed his remarks. One, with great humility, must undertake to oppose himself to a theory emanating from such a mind as that of Clerk-Maxwell; but one of the difficulties in the minds of all great mathematicians is that they must put their thoughts into mechanical methods in order to be able to weigh and measure directly. If we could only divest ourselves of the habit of considering all nature to be composed of molecules, we would come into another range of thought. I see no necessity for imagining all nature split up into infinite particles—infinite in number and infinitely small and large in size. I can readily conceive of a continuity of matter. In fact that thought is no novelty. It has been woven through all science, but we are so accustomed to limitations in our contact with nature that we are apt to conceive that those limitations actually exist beyond our mere perception of them. The wonderful analogy between the velocity of electricity and light is something that is no mere coincidence. It is true that light and electricity make themselves known to us through different senses. We can conceive that there is an identity of cause, and I will throw out a hint here that may prove one step towards the solution. The earth circulates with its sister planets around the sun; it is admitted that the sun and its system of planets are circulating around some other central point. We are perfectly unaware of the speed with which we are going through space together with the sun. Now I can readily conceive that the speed with which we pass through the sea of ether may be the speed with which light and electricity affect our senses. In other words I can readily conceive, and it does not require much stretch of the imagination, that we are passing through ether at a speed approaching two hundred thousand miles a second. If you consider that hypothesis it will immensely simplify the relations of electricity and light. We find that electricity is converted into light by two or three degrees increase of the transitory heat. A little below a thousand degrees light is invisible to our eye; a few degrees above a thousand it becomes visible; in both cases caused by electricity. So that electricity and light may be considered as having an identical cause. Now that hypothesis, of the most attenuated character, is one that I think should be dwelt upon, because it may lead finally to a solution of the question as to what is the cause of electricity and of light; that is to say, their identity may be found to lie in their common relation to the motion of the solar system through the universe.

We can put no limit to the solar system's speed of circulation; but there are, no doubt, other systems within systems, and all the forces that operate upon us in nature, may be the resultant of the varying speeds around different centres. Sir William Thomson's theory that the whole of matter can be summed up in a vibration is more and more well received. The fact that matter itself is simply infinitely small vibration and circulation of atoms, leads us to believe that there are enormous forces at work, forces that change ether, or whatever it may be, into form. Why matter should be chained to place and form requires a conception of some enormous force acting upon it, and I consider that force to be based on some enormous velocity of circulation of the solar system. This may be somewhat wandering from the theme, but still it is a speculation drawn from a speculation, as an induction spark from another spark.

A Member—I have a question to ask touching the wheel hypothesis. When you wish to increase the current without increasing the heat waste it is necessary to increase the area of the conductor. I should think that would increase the number of wheels inclosed in a conductor, and therefore increase the friction by increasing the amount of slip, and therefore increase the heat developed instead of decreasing it. I am not very familiar with the theory, possibly I am making a great error, but it occurred to me that such would be the case.

Professor Anthony—As I understood it, the more wheels there are in a conductor, the less is the amount of enegy spent in causing the slip over them, because you have more surface for slips in it. What we call a given current is accompanied by certain magnetic effects. That would mean that the wheels in space, enclosed by the conductor, are revolving at a certain rate. Now supposing those all to be revolving at that same rate and you increase the size of the conductors, increasing the number of wheels there are in it; then the wheels that are in the conductors will be set revolving at a less rate instead of a greater one, because there will be greater surfaces where the slip can occur. Whatever slip there is will occur over a larger surface, and consequently produce less motion.

Professor M. M. Garver—It is rather curious to me that in the matter of the heat developed in conductors, generally speaking, all the heat developed in the conductor, as Mr. Heaviside looks at it, is an action *around* the conductor. In that connection I cannot see, if it takes place around the conductor, why the law of temperature should hold as it does in the case of metals. Take for instance the case of copper; I believe the variation is about two-tenths of one per cent. for one degree Fahrenheit. If the same law holds, for minus 500 degrees Fahrenheit there should be no resistance and no heat developed in the conductors. I believe some experiments have been made in regard to the conductivity of copper at very low temperatures. I would be glad to hear from any one who has had experience in that line of investigation.

Mr. A. E. Kennelly—It is quite unnecessary for me to add my own personal views as to what I am sure is the universal sentiment concerning the paper to which we have had the pleasure of listening. But while it is full of food for reflection, from both a theoretical and practical point of view, there is one point more that I hope may be permitted to be brought forward—that is, the great difference between what may be called a working theory and an ultimate theory. Tracing back the history of the sciences as they are called, we see how very wide-spread they were, how numerous the sciences were; how in the Greek days every activity, from the motion of a cloud, or the motion of a body in the air, or of a body leaving the hand, was supposed to proceed from some superior cause; and gradually, as knowledge increased and investigation pursued its quiet path, those forces were singled out and found to be fewer and fewer; and so to-day we stand with a certain number which we still hope will be reduced and finally embodied in one. Dr. Moses has given us a very beautiful, I might almost say a poetic view of what he calls the infinitude of nature; but I think it would be a finer expression perhaps, if he will allow me the correction, if that infinitude be considered as proceeding rather from the unity of nature. In fact if we consider the days of Polytheism, the old Mahometan cry "There is one God" stands very aptly by comparison. In the theory of heat for example there were what we call now the crudest notions prevalent about four hundred years ago as to what its nature might be. Slowly our views have become clearer; and now perhaps heat is, in its theory, more complete than any other science. But the trouble with heat has been the same as it is now with electricity—the difficulty of getting first a theory that was workable and then a theory which would account for the facts clearly and consistently. We have listened to the explanation of a beautiful theory, a theory certainly worthy of the master minds that originated it; but somehow, it does not appear as though that theory were going to be the ultimate one which would satisfy us when we come to consider nature as a whole; and although it is a good working hypothesis—a peg upon which we can hang our thoughts—it would seem that after all we may hope for some better, some clearer, some simpler conception of the universal distribution of matter throughout space than pulleys and spinning wheels. When a vacuum was supposed to be the absence of everything from space, and nature, as we read in the old books, abhorred a vacuum, gradually people began to find out there must be something left; because phenomena occurred in places that had apparently been divested of their contents, which could not be accounted for if there were nothing there; and I do not suppose that any of us have any other conceptions of a vacuum further than this one thing;—that actions go on there through a space devoid of ordinary matter, but which we cannot conceive of as acting through nothing, and gradually as light came to be considered no longer on a corpuscular theory, it became necessary to invent a new ether, and finally the question came again, if we unite the two ethers will not the same ether do for both? Then came the electromagnetic theory of light, and that required an ether. Now from the brilliant experiments of Hertz and Maxwell we see clearly that those two ethers are one and the same; at least we cannot distinguish between their properties. The ether that we suppose will propagate light, is surely not one that we can readily unite with the idea of spinning wheels in space. The mere fact that the thing is difficult to conceive of is no bar, of course, to its truth. But surely we are entitled to the expectation that nature in her infinity is infinitely simple. Surely it is in this ether that we have to investigate something which unites more readily the phenomena of gravitation of light and of electricity. If we have for example a large vessel full of incompressible fluid—water will answer—and we introduce into the water two little jets, small in respect to the whole vessel, and we cause the vessel to be hermetically sealed, full of water, with those two jets in it; then if we force water out of one jet, back through the other, causing a circulation to take place through that liquid, we shall find—with the one reservation that there shall be no vortex motion in the liquid—that all the particles will advance in ranks—shoulder to shoulder and eyes front—and the lines that will be pursued by the individual particles are, strangely enough, the lines which are followed, we have every reason to believe, by magnetism, by heat, in its permanent state, through solid bodies, and by gravitation. Surely there is some grand principle underlying that great class of phenomena which some day in the future will join them all into one coherent mass, and by which we shall see not only electricity but all the other forces of nature united.

The point that Professor Garver mentioned about the conductivity of copper at a very low temperature is one which has certainly a very great practical interest, although we are not likely to be able to live in a climate where for the sake of our conductors we can submit to two or three hundred degrees below zero. But I think—and I have no doubt others here will correct me if I am wrong—that experiments have been made at minus 40 degrees centigrade, and they showed a very large increase in the conductivity of copper, and the coefficient of temperature was very much larger at that point than it was higher up the scale; and in fact the late Sir William Siemens had a very interesting theory, in which he assumed that the resistance at a very low temperature was a limited amount which was very small indeed and rose rapidly at first and slower and slower afterward. That is contrary to our orthodox views about conductivity of copper for high temperatures, but it is a view which is interesting in itself.

Mr. Townsend Wolcott—Regarding the existence of a medium, Professor Anthony has given voice to the most general opinion in saying that action at a distance is unthinkable. I believe this is the view which Sir Isaac Newton took; but it must not be forgotten on the other hand that Roger Coates said that there is no more *a priori* reason for disbelieving in action at a distance than for any other experimental facts that we have; and it is this same Roger Coates of whom Sir Isaac Newton said, in speaking of his untimely death:—"Had he lived we should have known something." I think that a part of the difference between two classes of thinkers arises from their having a different conception of the meaning of the word medium. In the present state of science, if we do not make the word medium mean too much, it is, in my opinion, practically demonstrated that there is a medium. If we say that action at a distance through space—vacant space—is unthinkable, what do we mean by space? If we mean simply extension, the concept of extension being simply three dimensions, it is unthinkable. But in conceiving of a medium we are too apt to make the word mean too much. Now Professor Stokes has shown that the luminiferous ether acts like an elastic solid; that is to say, the mathematics of solid elasticity apply to the ether; but if the ether be an elastic solid it must be an exceedingly solid kind of a solid. I forget how much pressure there would have to be, but it was something enormous. Now we know that the ether is not such a solid as that. Again taking the modern theory of the action of the dielectric—Faraday's theory, we will call it—it is a stress in the dielectric. Now, the mathematics of stress are equations similar to the equations of the stress in a solid body—that will apply to similar electric phenomena in a dielectric. However, there can be no real stress in the sense in which we understood the word, because the very bodies which are not susceptible of sustaining a stress are the ones which are the best dielectrics. In fact a vacuum, which we do not consider a body at all, is a dielectric, and according to some electricians it is the very best of insulators, and metals which generally are capable of sustaining a great deal of stress are all conductors, and according to the electrical theory are the bodies in which the state of electric stress cannot exist; it gives way immediately and produces what we know as current.

Dr. Michael Pupin—I wish to express my feeling of obligation to Professor Anthony for his lecture on the modern theories; and with his kind permission to add a few comments as a supplement to his review. We know what ideas Faraday had about dielectrics, and the function which a dielectric has to perform in the transmission of the electric force from one part of space to another. We know that Faraday supposed the dielectric to be filled with small particles—we will not say molecules or atoms, because we do not know whether these things really exist—we say simply small particles which have the property of polarity. In what that polarity may consist we do not know. We may suppose it is of the same kind as the magnetic polarity in the case of soft iron—that every small particle is in fact a perfect magnet, having a positive and a negative pole. That theory has been worked out by Professor Helmholtz, and he reduced the equations for the distribution of the stress in the dielectric, exactly the same as Maxwell did. In fact the equations which Helmholtz obtained are somewhat fuller. Now assuming it to be true that a dielectric consists of very small particles each one having the property of polarization, from that one property of the dielectric all the electro-static and all the electro-magnetic phenomena can be explained. I do not see that it is necessary to go any further into the consideration of any wheels working with any other wheels. To be sure Maxwell did work out a theory, I think in 1862, to which reference has been made this evening; but he gave it up, and in his second volume he refers to this theory in a sort of off-hand way, saying that some years ago he worked out a theory of electricity on the vortex motion hypothesis of Sir William Thomson; that could be found there, and taken for all it was worth. Now Professor Helmholtz, supposing the medium to have only these properties, namely, the properties of polarization, and—referring to the stress in the metal—says that if there is any electric disturbance, whether it be an electro-static disturbance or an electro-magnetic disturbance, the same disturbances we have in the conductor must be propagated in the whole dielectric, because disturbance in the electric state of the conductor will cause a disturbance of the metal, and that disturbance of the metal gives the electro-magnetic action.

Helmholtz's papers are not published yet (but I expect they will be published very soon); to be sure they do not contain anything new, because these things have been worked out before by Sir William Thomson, and I think by Maxwell at first.

Another point. Every one of the speakers this evening has spoken about forces. The term force is a very elastic term and may mean anything. In fact, I think every man has his own idea about force. But if we are to discuss and use the term force we must have a common definition of force. What is force? Where are we going to find the definition of it? I think if we are to treat sciences from the mechanical standpoint, then we must define force mechanically. That is, we must take motion as containing the full definition of force, and if you do that you will fall back necessarily on the Newtonian definition of force, that is, as producing nothing but motion; that is the elementary definition of force. When we speak of electric forces and magnetic forces we certainly deal with something which will produce more than motion alone. In fact I think that it is not unreasonable to believe that Faraday was led to his investigation of the functions of electrical phenomena by considering Ampere's integral law, knowing that a current flowing through a conductor will act upon a magnetic pole just the same as if the wire was an empty shell having a magnetic moment equal to the strength of the current. Now, in every department of natural science it is always desirable, and in fact it is the highest aim of every physicist to deduce, not the integral law but the differential law. Newton achieved his great success when he found the differential law—the law of universal gravitation. Ampere thought his integral law would be of little use to him if he did not know the differential law; namely, the law which determines the action of each element of one conductor upon each element of any other conductor or upon itself. He said, let us now resolve this integral action into elementary actions. He did it, and he found that each element of the conductor—supposing it to act upon a pole or upon an element of another conductor with a force which is proportional, but which does not act in the line of action between the two particles—exerts a force which does not act in the line connecting two particles, but acts perpendicularly to the line. Another differential law has been lately deduced—in the last twenty years—by Maxwell, Weber and Helmholtz. Some of these laws suppose that there is not only a force perpendicular to the line of these two particles, but also that there is something that tends to turn the element; so that we have to deal here not only with forces which are determined by laws of mechanics, but with forces that lie entirely outside of that. Therefore we have always carefully to distinguish what we mean by force. Is it purely mechanical force, is it a force which produces, besides motion, something else? We cannot speak of chemical forces in the same way as we speak of mechanical forces, because mechanical forces are forces limited by the definition of Newton, and they produce nothing but the motion in the mass. Chemical force produces heat, it produces chemical composition and decomposition; it produces light and it may produce motion also. I think Faraday when he saw this elementary law thought that he had not to deal here with pure forces, such as the gravitating force, where the force is always in the line connecting the two points acting upon one another: and that it is not an elementary force, and if it is not an elementary force it may perhaps be explained by some mechanism.

The other point which I would like to bring up refers to the conductivity of metal. It has been said here that the rule—I won't call it a law, I will say the rule—is that every metal increases its resistance with temperature, and that according to calculation at certain low temperatures the metal ought not to offer any resistance whatever. The fallacy is self-evident; and that fallacy would be self-evident not only in the case of the rule, but also in the case of the law. When we speak of a law we do not mean something absolutely true. Clifford has defined the meaning of law;—a law is true only in those conditions under which the construction of the law was observed. The law of heat, the law of light, the law of electric current, all were observed, not in a vacuum, but in space; not in a temperature of several million degrees, but in temperatures which we can get ranging from minus 80 degrees to, perhaps, 1000 degrees centigrade. The law above those limits may be true or may not be true. Every law may be represented by a certain curve. Where the curve does not run from minus infinity to plus infinity we know a very small part of that curve; the rest we do not know.

Professor Garver—I see that I was misunderstood. I was speaking in regard to the change due to temperature as being incompatible with that due to the action taking place in the medium inside of the conductor; and at first sight it seems that the variation in conductivity due to the temperature in the conductor was at variance with the view that the action took place outside instead of inside the conductor. Since thinking it over, I have arrived at what seems to be a plausible answer to my own question, namely:—that the conductor being actuated by heat, the particles are in motion due to the action of heat while in that condition. Now, as the temperature of the conductor goes down, the heat action becomes less and less, and it then approximates to what I believe it is supposed to be—a hole through the medium.

Mr. Nikola Tesla—I want to suggest a practical solution on which I have not taken a patent, but which is cheerfully offered in case any gentleman wants to patent it; and that is, there seems to be no doubt to-day that light and electricity are one and the same, and that between them there is only a difference in degree. Now the question resolves itself into how to produce a number of undulations that would equal those of light, which you can perceive. We know that if you put two coils in inductive relation you can, by passing through one coil an undulating current, produce in the other two distinct currents. From that secondary we can again act in the same manner upon a third. I have figured that at that rate it would require about twenty-three conversions. If you assume an efficiency of 80 per cent. in the first you can assume one of two per cent. in the last secondary, which is the twenty-third.

While we are convinced that light and electricity and electro-magnetic action are the same, yet there seems to be a difference between light and electricity in this way—that we cannot maintain light in a static condition. On the other hand we can maintain electricity so. Again light and magnetism are similar in this respect. We know well that we can magnetize a steel bar and it will hold magnetism indefinitely. We can magnetize also a soft iron bar and it will lose the magnetism soon. Now there seems to be, from what Professor Anthony has so admirably set forth, a possibility of producing a magnet of such qualities that it would for an indefinite time, say for a year, or two years, or three years, discharge continuously its magnetism after the cessation of the current which energized it. I attempted in my early days to do that, but it does not work.

We can store light for a moment. That is if we expose certain bodies which take on light and keep it for awhile—if we expose such a body to an arc light or to a source of very intense light we will find that it will take up and emit light for a short time; but when the source of light is intercepted the reproduced light will instantly fall down and the little that remains will gradually disappear, similar to that little remnant of magnetism that remains in the big bar of iron. If we plot the curves for magnetism and for light we find them to correspond. We know that electricity can be stored (I understand now the difference which Professor Anthony has brought out between potential difference and electromotive force), I mean we can take a condenser or a Leyden jar and store up electricity in any quantity, so to speak, and keep it there for a considerable time, and then discharge it at will. We cannot do so with light nor with magnetism; and yet we know that all these are really one and the same thing, and that there is only a difference of degree.

Dr. Pupin—I would like to ask Professor Anthony to define the term "electromotive force."

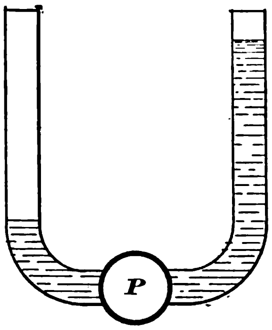
Professor Anthony—It is one of the most difficult things in the world of which to give a definition, and I never pretended to any ability at giving definitions. We all know that in a battery there is something that develops an activity. We know that the conductor gets warm. We know that around the conductor there are what we call magnetic forces, and I believe that there is an activity set up in the whole space around it. Now, whatever that is inside of the battery that gets up this agitation I call electromotive force. Furthermore, we know that if we move a wire across the magnetic lines of force there arises something which, if that wire form a closed circuit, will produce what we call a flow of electricity. We know it is a flow of electricity because under proper conditions the wire will get warm, because also there are magnetic effects developed by it. There is something that takes place—an agitation is set up in that wire—and I consider that something, I do not pretend to define it, I do not pretend to know what it is, but there is something there in consequence of the movement of that wire across the magnetic lines of force that constitutes what we call electromotive force. It is something, to use the language of electrical theory, that puts electricity in motion, and there is just the action I referred to in the paper, in which we may have electricity in motion, taking this theory of a current in a conductor, without any difference of potential. Suppose, for instance, I have a perfect circle of wire, and I thrust the north pole of a magnet perpendicularly into the centre of that circle. We know that lines of force cut that circle, all around, in every part of it; and my idea is that when that magnet is thrust through there we know that a current is set up around that wire; that when that magnet is thrust through, whatever there is that constitutes a magnetic field acts in some way to set up this current, and acts in every part of the wire so that there is a current set up without there being any difference of potential between any two points.

Dr. Pupin—How would you measure the heat produced in the wire? Is that subject to Joule's law?

Professor Anthony—I should say so, certainly. Electromotive force is measured in the same *terms* as difference of potential, of course.

Dr. Pupin—It must be the same.

Professor Anthony—I do not think so any more than in difference of level. We measure difference of pressure, for instance, by difference of level in case of water. To illustrate it (illustrating on the blackboard), here we have a tube. Here, at P, we have a pump in that tube. I set the pump turning. The water before was at the same level in both upright branches. I now set the pump turning and the water comes down one branch and goes up the other. That difference of level will measure the difference of pressure; but that pressure was produced by turning the handle of this pump. Now the turning of the handle I call the water moving force. This constitutes a difference of potential, a difference of gravity potential which opposes my turning of the handle.



Dr. Pupin—Therefore the work done measures the difference of level?

Professor Anthony—It may be measured by the difference of level.

Dr. Pupin—But the work done measures the difference, and the turning of the handle measures the work. In the same way the electromotive force is not a force at all in the usual sense of the word. It is the work done to make the difference of potential, and that is what the difference of potential is—the work done.

Professor Anthony—Suppose that we do not produce any difference of potential, as in the case of the closed ring conductor into which the pole of a magnet is thrust?

Dr. Pupin—But I think we do. That is a well-known problem. The difference of potential is equal to the work done. Substitute for each element in such a closed ring an infinitely small Daniell element, all around. Of course that is practically impossible, but it is conceivable. We can place infinitely small Daniell elements, connecting them together around the circle so that they will form a closed circuit. Is there not difference of potential there?

Professor Anthony—If you have them infinitely small so that each Daniell element acts on each element of the wire, then I should say there was no difference of potential from one end to the other, and we have the electromotive force of the Daniell element producing the result entirely and nothing else.

Dr. Pupin—But in that infinitely small battery between each pole there is a difference of potential between each two poles—in every one of those infinitely small batteries—there is a difference of potential. So I may say between each one of the infinitely small elements of the wire there is a difference of potential, and they are connected in series and the current runs around.

Professor Anthony—Let us take it in another way. Suppose there is a circular tube containing a gas or liquid, whichever you please. Now, can we not conceive of such a thing as something acting simultaneously upon every single element, no matter how many you consider there may be of them, and acting all at once so that every one of these elements will move forward at the same instant, and that there is no difference of pressure anywhere in that case. Now difference of pressure is what I consider as equivalent to difference of potential. In other words, what we call difference of potential electrically is due to a disturbed electrical distribution, and until you have a disturbed electrical distribution there is no difference of potential. Now, in the wire where we have a perfect circle and thrust into it the magnetic pole, if we act on every element of that wire simultaneously there is no disturbed condition of potential, and after you have stopped the magnetic pole you can conceive that your electricity has been shifted around through the whole of it without there being a disturbance there—without any difference of potential when you are through. You stop the movement of the magnet; the current stops. Your electricity does not fly back again. But let us cut that wire in two and leave an opening in it. Now force the magnetic pole through the middle and you tend to make a motion around in the same way. Electricity is heaped up at one end making pressure there. It goes away from the other end; and the moment your magnet stops the motion then the electricity flies back and produces a current the other way.

Mr. Francis B. Crocker—It seems to me that the last illustration of Professor Anthony's will give us a solution of the problem and reconcile both sides of this controversy. He assumes that the wire is opened at a certain point, and if you thrust a magnet in you will get the total difference of potential which is a calculable quantity; we could calculate that—predict it from known electric and magnetic effects. Now it seems to me that when the gap in the ring is closed you get that difference of potential spread over the entire circle, and that difference of potential spread over the entire conductor produces the current. Now it is heaped up at the opening because it cannot pass that point, there being no conductor there. But it seems to me the same total potential difference—which is what always produces a current, or rather which usually produces a current, to make the statement a little less objectionable—is heaped up there; but if we close that conductor at that point, isn't it natural that that potential should be distributed uniformly throughout the entire circle? But being distributed in that way it produces the same effect as it would if it were concentrated at one point through the same resistance, and it seems to me that although there is no difference of potential which you could put off by itself, yet the same difference of potential exists throughout the circle. In other words, the integral of the difference of potential is the same in both cases, because the flow in that circuit and the $C^2 R$—the Joule effect, and all those other electrical phenomena which we understand perfectly,—will be precisely that due to the difference of potential which we get when we open the circuit. I do not think there is a gentleman here who will doubt that fact, that the difference of potential which we get when we open the circuit, as assumed by Professor Anthony, is the same potential difference of electromotive force which produces the current and heating effect and magnetic effect; and, therefore, if that heating effect which we get from the closed circuit corresponds with the difference of potential which we get when we open the circuit, isn't it not only natural but almost necessary that we have the same difference of potential spread throughout the circuit and producing a current through the same resistance? And I should say that, theoretically, the way to look at it was to divide it up into elements. It would be utterly impossible to treat any complicated phenomena in force without assuming them divided up into elements, throughout which elements you can make certain assumptions. That is, you have to differentiate. You have to take a certain element and treat it by itself. Taking a certain element anywhere we have a certain difference of potential, a certain resistance and a certain resulting pressure. Assume the ring, for instance, to be divided into a thousand equal portions. Then while with $\frac{1}{1000}$ of the difference of potential found when the circuit is open we will have 1000th of the resistance of the whole ring, and therefore we will have the same current that we would with a thousand times potential difference and a thousand times the resistance. That seems to me to be a particular case. It is a limiting case; and what is true just before the limit is true at the limit, according to Newton. Therefore, if we make it uniform and make a limiting case out of it, a case which is as far as we go in that direction, then what is true just before the limit is true at the limit.

Mr. Wolcott—Mr. Crocker's idea of the circulation of current in the ring is a good deal like the relation of east and west on the globe. We can have a point west of New York, and by going in the other direction it will be east of New York. If you take Mr. Crocker's conception and integrate the difference of potential all around the ring, when you get back to the starting point, that point has two potentials, and so it must be. It is like any other cyclic region. One of the most familiar cases of that is the magnetic potential. In an infinite straight conductor the potential at any point has an infinite number of values, but it is only on some such conception as that that you consider there is any difference of potential. That is by going around until you come back to the same point you have increased the potential by the cyclic constants of the curve.

Mr. Kennelly—I think we are very much indebted to Professor Anthony for having called attention to one of the leading misconceptions of the day. There is a constant conflict between difference of potential and electromotive force, and I think nothing can be better in a society of this kind than to settle such differences. I think Professor Anthony has given us a very clear solution in this way, that whatever produces a current is electromotive force; that electromotive force may or may not be accompanied by a difference of potential. We do not recognize potential as we recognize current. We are led to it by a series of abstractions. Potential was introduced from a purely theoretical and mathematical basis. The potential function first existed in gravitation. It was introduced into electricity by similarities which exist between gravitation laws and electrical laws, in their mathematical form; and potential is something which causes work to be done—in virtue of which work can be done. The potential is measured by work which can be done by bringing a unit of electricity to the point where potential is measured.

Dr. Pupin—I do not agree with Mr. Kennelly that the potential is a mathematical conception any more than I would agree with him that the work is a mathematical conception. Who would say that to raise a barrel of flour to the gallery above us here was a mathematical conception? To charge a conductor with a certain amount of work. If we do not stick to this term work we cannot make a step of progress, because we cannot take in the conservation of energy. Potential is not a mathematical conception. Potential is as concrete as I am, standing here. It is the amount of work done. Mr. Kennelly said that the difference of potential is something which causes the work to be done, and a little while before it was said that electromotive force is the cause of the electric current. Now these two things seem to be one and the same, because to cause the current to flow is the work done; but I will not discuss that any more seeing that my colleague [Mr. Crocker] has expounded my idea of this circular conductor in a very nice and masterly way.

At the close of the discussion, the chairman announced the next meeting of the Institute for the 18th of February, when a paper will be read by Mr. William Maver, Jr., and the topic will be, "The Practical Working of New York's Electrical Subways."

Adjourned.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—GROWTH OF MEMBERSHIP.

The following-named gentlemen have been elected to Associate Membership in the American Institute of Electrical Engineers since the publication of the revised catalogue, November 1, 1889:—

AT COUNCIL MEETING, NOVEMBER 12, 1889.

Wm. C. Benbow, electrical expert, Thomson-Houston Electric Co., Boston, Mass.

Geo. P. Wardell, U. S. Electric Lighting Co., 19 Cedar street, Newark, N. J.

I. E. Winslow, railway expert, Thomson-Houston Electric Co., New York.

Sidney Z. Mitchell, electrical expert, N. W. Electrical Supply and Construction Co., Seattle, Washington.

F. H. Smith, civil engineer, 227 E. German street, Baltimore, Md.

Franz Schulze-Berge, assistant, Edison's Laboratory, Orange, N. J.

Frankland Jannus, solicitor of patents, 928 F. street, Washington, D. C.

Hammond V. Hayes, electrician, American Bell Telephone Co., Boston, Mass.

Francis G. Daniell, railway expert, Thomson-Houston Electric Co., 403 Sibley street, St. Paul, Minn.

H. F. Parsell, Jr. (student Stevens Institute), 31 E. Twenty-first street, New York.

Henry G. Fiske, electrician, Croton Magnetic Iron Mines, Brewsters, N. Y.

Chas. W. W. Spicer, Edison Phonograph Works, Orange, N. J.

Charles Gorton, electrical engineer, Clark Bros., Belmont, N. Y.

John J. Moore, Thomson-Houston Electric Co., 425 E. Twenty-fourth street, New York.

DECEMBER 3, 1889.

Huntington Lee, representative F. H. Whipple, 18 Cortlandt street, New York city.

Captain S. W. Roessler, Corps of Engineers, U. S. A., Willett's Point, Whitestone, N. Y.

E. V. Bailliard, electrical inspector, Electrical Accumulator Co., 44 Broadway, New York.

Chas. J. Bogue, electrical expert, New American Arc Light Co., 256 W. Fortieth street, New York city.

JANUARY 7, 1890.

Alfred A. Dion, electrician, Intercolonial Railway, Moncton, N. B.

John E. Davies, Professor of Physics, University of Wisconsin, Madison, Wis.

Gilbert Wilkes, assistant to inspector of electric lighting, Navy Department, Washington, D. C.

Justus B. Entz, electrical engineer, 1,065 Madison avenue, New York.

Geo. W. Moss, station manager, C. & S. A. Tel. Co., Tehuantepec, Mexico.

H. Doijer, assistant of physics, Polytechnical School, Delft, Holland.

Wm. J. Hancock, superintendent of telephones, Department of Public Works, Perth, Western Australia.

Harris Henry Eley, W. C. & S. W. Telephone Co., Bristol, Eng.

Will F. White, secretary and treasurer Western Engineering Co., Kearney, Neb.

Donald M. Bliss, electrician, Canada Electric Co., Amherst, N. S.

Alexander S. Brown, general manager Morristown Electric Light, Heat and Power Co., Morristown, N. J.

The following Associate Members have been transferred to full membership, upon approval of the Board of Examiners:—Dr. Chas. B. Dudley, Altoona, Pa.; J. T. Marshall, Harrison, N. J.: Leigh Carroll, Birmingham, Ala.

COLLEGE NOTES.

Cornell University.—Sibley College.

The course in mechanical laboratory practice for the seniors in Electrical Engineering has been modified so as more completely to meet their requirements. Preparations have been made for some interesting mechanical and electrical tests. A completely equipped Thomson-Houston arc light plant has been placed in the laboratory. The power is furnished by an "Ideal" engine which was constructed in the Sibley machine shop. A Brush constant current motor has also been placed in this "station," the Thomson-Houston dynamo furnishing the current. Complete efficiency tests of the engine, dynamo and motor will be made under various conditions. The work will be under the general charge of Professor Smith as heretofore; Professor Ryan will have charge of the electrical tests.

A new system of distribution of incandescent lights about the campus is being considered by Professor Ryan. An Edison plant will furnish lights for the buildings which are nearest to Sibley. The more distant buildings will be supplied from a Westinghouse alternate current machine. An accumulator system will furnish light, if needed, during the day, or at anytime when the dynamos are not running.

A Pritchard electric water wheel governor has been received by the department. It is expected that with this governor the turbine furnishing power for the Sibley shops will be regulated sufficiently well to be used for the new incandescent plant.

At a recent meeting of the Electrical Association the following officers were elected for the ensuing term—J. W. Cowles, president; G. D. Hulett, vice-president; H. P. Broughton, secretary.

The following are the thesis subjects chosen by the seniors in Electrical Engineering:—H. P. Broughton, "The Vacuum of the Glow-lamp;" H. Cochrane and E. C. Sickles, "The Design of an Electric Lighting Station for the Cornell University Campus, Using Water Power;" P. A. Calisdell, "Effect of a Series Coil on the Neutral Point of a Dynamo;" J. W. Cowles and L. W. Healey, "A Test of the People's Electric Railroad Line at Scranton, Penn;" S. B. Fortenbaugh and H. A. Sawyer, "Hysteresis;" A. H. Herschel and E. A. Wilhelm, "A Study of the Converter and its Efficiency as Influenced by Heat;" G. D. Hulett and S. J. Larned, "Efficiency Test of the Thomson-Houston Electric Street Railway at Syracuse, N. Y.;" A. B. Levy, "A Study of the Arc Light and Arc Light Carbons;" M. Levy, "The Effect of Electricity on Traction;" J. E. Greenawalt and J. S. Loomis, "A Theoretical and Practical Investigation of the Brush Electric Motor;" D. B. Kennedy, W. H. Powell and J. C. Ramage, "A Study of Hysteresis as Exhibited in the Cores of Armatures and Transformers;" E. A. Rumsey, "The Design, Construction and Testing of an Electric Motor;" W. B. Tobey and G. H. Walbridge, "Test of the Stanley Alternate Current Arc Light Dynamo;" H. F. Thurber and John A. West, Jr., "Determination of the Magnetic Curves of Various Grades of Iron;" W. N. Smith, "The Application of Electric Motive Power to Elevated Railways;" M. E. Thompson, "A Study of Electric Meters;" O. A. Stranahan, "The Design of an Electric Lighting Station for the Cornell University Campus;" F. F. Goodwin, "A Study of Arc Lamps."

A large amount of original work is being done by seniors in the physical laboratory in the way of investigations of different electrical phenomena, and in the construction and calibration of instruments to be used later in the year for their thesis work.

An interesting set of experiments has been made by M. Levy, '90, to determine the effect upon friction of a current passing through the surface of contact of iron sliding and iron rolling upon an iron track. With a 20-ampere current the co-efficient of friction was increased about fifteen per cent. F. C. Caldwell, '90, is continuing the work of Archbold and Teeple, '89, in the investigation of the "Ball and Point Effect with Alternating Currents." He proposes to make a study of this phenomenon in hydrogen, carbon dioxide, and air at different temperatures and pressures. W. G. Rappleye, R. G., is making a detailed study of the quadrant electrometer invented by Professor H. J. Ryan, and described by him at a recent meeting of the American Association for the Advancement of Science.

As has been the custom in previous years the spring vacation will be spent by a large number of the students on inspection tours. This year two routes have been arranged for the students in electrical engineering. One section will visit Philadelphia and New York, the other will visit New England by way of New York, returning to Ithaca by way of Troy and Schenectady.

THE EDISON GENERAL ELECTRIC COMPANY'S ANNUAL MEETING.

The Edison General Electric Company's annual meeting was held, January 20, at 44 Wall street. The first annual report of the company was read, and trustees for the ensuing year were elected as follows:—C. H. Coster, Joseph S. Decker, Thomas A. Edison, J. H. Herrick, Samuel Insull, E. H. Johnson, A. Marcus, Carl Schurz, Francis S. Smithers, Henry Villard, and J. Hood Wright. All of the old trustees were re-elected with the exception of Mr. Marx, whose place was taken by Mr. Decker. A meeting of the Board of Trustees will be held shortly, and Henry Villard will probably be elected president, and A. Marcus, secretary.

The first annual report, after reciting the purpose for which the Edison General Electric Company was formed, viz.: the acquisition of the properties of the Edison Electric Light Company, the Edison Machine Works, the Edison Lamp Company, and Bergmann & Co., continues as follows:—"A basis of exchange was offered to all stockholders, and in pursuance thereof this company has acquired: (1) 14,003 shares out of the 15,000 of the capital stock of the Edison Electric Light Company; (2) the total capital stock ($750,000) of the Edison Machine Works; (3) the total capital stock ($750,000) of Bergmann & Co.; (4) the total capital stock ($250,000) of the Edison Lamp Company. The purchase of the manufacturing companies carried with it the acquisition of the stocks of the Edison United Manufacturing Company, and of the Canadian Edison Manufacturing Company. * * * *

The properties of the Edison Electric Light Company are personal, consisting almost entirely of patents acquired from Thomas A. Edison, and of bonds and stocks received as license fees from local illuminating companies throughout the United States. * *

The United Edison Manufacturing Company has been reorganized, and is now working with a capital of $1,000,000, $500,000 of which has been paid up. The Canadian Edison Manufacturing Company has charge of the Edison manufacturing business, except the making of lamps, in Canada. Its shop is at Sherbrooke, near Quebec, and 175 men are at present employed. The Sprague Electric Railway and Motor Company has at present in use 3,000 of its motors, of all classes, applied to no less than 150 different industries, and varying from ¼ to 75 h. p. each. The number of street railway cars equipped with electric motors during the last year by the company was 551. It was first decided to acquire only a partial interest in the capital stock of this company by the purchase of the entire issue of its preferred stock ($400,000) for cash at par, with a bonus of $120,000 in its common stock. Since that time the Board of Trustees have resolved to offer to the holders of the outstanding common stock of the Sprague company ($880,000 out of a total of $1,000,000) to exchange their holdings for an equal amount of Edison Electric Light Company's stock, 66⅔ per cent. in dividend stock, 33⅓ per cent. in trust certificates. The stockholders have accepted the proposition, and the exchange of stock will soon be made.

During 1888–1889 the receipts of the Edison Electric Light Company from lamp royalties and from interest and dividends from licensed companies were $160,520.24, showing an increase of $46,529.13 over the preceding year. * * * * * *

After all bad and doubtful debts have been charged off, and after making a liberal allowance for depreciation of plant, dividends were declared by the Edison Machine Works, by Bergmann & Co., by the Edison Lamp Company, and by the Canadian Edison Manufacturing Company for a total of $587.50. As the earnings of the Edison Electric Light Company over and above its outlays for patent litigation and ordinary expenses were largely represented by the securities acquired from the local illuminating companies, it was deemed better to let these accumulate in the treasury. The net accumulation by the Light company during the year ending October 1, 1889, amounted to over $150,000. * *

The new business in sight in every department is on such a scale that if the company succeeds in increasing its capacity sufficiently to execute it, the gross receipts in 1890 will be twice as large as in 1887–1888.

Extraordinary activity may be expected during the present year, in consequence of the erection of a number of new central stations for the distribution of light and power in New York, Boston, Chicago, Milwaukee, and other large cities. The income of the Edison Electric Light Company from license fees in 1890 promises to be so large as nearly to double its present holding of securities of local companies, and the new plants insure orders to the amount of several millions to the company's manufacturing establishments. There is every indication, too, that the electric railway business will continue to grow at a rapid rate. The sales of plants for isolated lighting also show a great increase.

The following is the company's statement:—

BALANCE SHEET OCTOBER 31, 1889.

		DR.
Property accounts:—		
Permanent plants	$70,197 56	
Rental plants	25,345 80	
Supplies	5,807 11	
		$100,850 47
Cash accounts		5,977 32
Patents		1,032,010 17
Customers		8,267 94
Customers, Elgin Ed. Lt. Co.		1,817 31
Bills receivable		60,768 10
Trust Fund No. 1		51,612 39
Trust Fund No. 2, D. M. Co.		25,348 08
Doubtful and extended accounts		8,009 69
T. A. Edison contingent account		1,019 30
Open accounts		33,542 09
Stock and bonds		1,749,578 00
		$3,073,790 86
		CR.
Capital stock		$1,500,000 00
General liquidation account		47,864 63
Sinking fund		1,029,671 21
Bills payable		22,747 10
Accounts payable		7,382 54
Open accounts		2,518 75
Profit and loss accounts:—		
Profit and loss, September 30, 1889	$466,114 34	
Profit and loss, current year to date	10,170 31	
	$476,284 65	
Less expenses current year to date	12,628 02	
	$463,656 63	
Less amount provisionally transferred by item next below	105,000 00	
		$358,656 63
Special profit account		105,000 00
		$3,073,790 86

STATE ELECTRIC LIGHT ASSOCIATIONS.

The efforts of Mr. Allen R. Foote, chairman of the committee on legislation of the National Electric Light Association, in organizing local associations in the several states are meeting with much success.

The Rhode Island State Electric Lighting Association was organized January 7 at a meeting of central station companies, doing business in the state, at which a majority of the companies, and about seventy-five per cent. of the capitalization, in the state was represented. Letters were read from officers of companies who could not attend, expressing their approval of the movement and pledging their co-operation.

The organization was effected by the election of the following officers:—*President*, Saml. P. Colt, Bristol Electric Light Co.; *Secretary*, Saml. G. Stiness, Pawtucket Gas & Electric Light Co.; *Treasurer*, Marsden J. Perry, Narragansett Electric Lighting Co.

The officers of the association constitute its executive committee.

The New Hampshire Electric Light Association started its career January 9th.

The response to the call for the meeting of central station was nearly unanimous; over eighty per cent. of the capital employed in central station lighting in the state being represented in person, and much of the remainder by letter.

The desirability of forming a state association was fully discussed and the proposal was cordially endorsed.

The organization was effected by the adoption of by-laws and the election of the following officers:—*President*, Alonzo Elliott, Manchester; *Vice-president*, F. W. Eastabrook, Nashua; *Secretary* and *Treasurer*, Edgar Woodman, Concord; *Executive Committee*, Alonzo Elliott, Manchester; F. W. Eastabrook, Nashua; H. W. Burgett, Dover.

A resolution was adopted directing the secretary to send an invitation, with a blank application for membership, to every central station company in the state.

The Maine Electric Light Association:—The electric central station companies in the state of Maine held a meeting at Portland, and organized a state association, on Saturday, January 11.

The meeting fully represented the electrical central station interests of the state and was clear headed and decided in its action.

An association was organized under the above title by the adoption of by-laws and the election of the following officers:—

President, Geo. P. Westcott; *1st Vice-president*, J. W. Wakefield; *2nd Vice-president*, F. M. Laughton; *Treasurer*, W. R. Wood; *Secretary*, F. A. Sawyer; *Asst. Secretary*, Geo. E. Raymond; *Executive Committee*, Geo. P. Westcott, Portland; J. W. Wakefield, Bath; F. M. Laughton, Bangor; W. K. Dana, Saccarappa; W. E. Maxey, Gardner.

A copy of the by-laws and an application for membership blank will be sent to every central station company in the state. It is expected that no company will be without a membership.

MICHIGAN ELECTRIC LIGHT ASSOCIATION:—A meeting of the companies doing business in the state of Michigan was held at the office of the Brush Electric Light Co., Detroit, January 17, to organize a state association.

The association organized by adopting by-laws and electing the following officers:—*President*, Geo. Peck, pres. Edison Illuminating Co. of Detroit; *Vice-president*, Jas. R. Dee, general manager of Peninsular Electric Light and Power Co., of Houghton & Hancock; *Secretary* and *Treasurer*, Jos. E. Lockwood, general manager of Brush Electric Light Co., Detroit; *Executive Committee*, George Peck, Detroit; Jas. R. Dee, Houghton; Jos. E. Lockwood, Detroit; W. H. Powers, Grand Rapids.

One vacancy in the committee was left to be filled after the filing of membership applications.

The secretary was directed to send a copy of the by-laws and a blank application for membership to every company in the state.

The association will give its first attention to the establishing of a general system of rules and regulations for the wiring of buildings, so as to secure the safest and best construction and service.

The ILLINOIS ELECTRIC LIGHT ASSOCIATION was formed, January 18, at a meeting held in the rooms of the Chicago Electric Club. Details of the organization will be found in Chicago correspondence (page 64).

A resolution was passed directing the secretary to have the constitution printed, also blank form of application for membership, and a form to secure sundry items of data, and to send copies of the same to every company, firm or person in the state eligible to membership; with a letter inviting them to become members of the association as organized. It is expected that this association will develop into one of the largest state associations in the country. There is a sufficient number of local companies in Illinois to supply the material.

THE COPPER TARIFF.—THE PETITION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION FOR THE ABOLITION OF DUTIES.

The committee appointed at the last meeting of the National Electric Light Association to petition the proper committee of Congress for the abolition of duty on copper, appeared at Washington, January 16, through Mr. Phelps, who presented the following petition to the Committee of Ways and Means, with the subjoined address.

Petition to the Honorable Committee on Ways and Means, House of Representatives, U. S. A.

The subscribers were appointed a committee to petition your honorable body for the abolition of duty on copper ingot, plate, bars, rod and wire. We represent the National Electric Light Association, a body composed of representatives of electric lighting companies throughout the United States, and also of manufacturers of and dealers in electric lighting apparatus and supplies.

The resolution appointing this committee was passed without a dissenting voice. We, therefore, have the honor to present this petition, earnestly requesting that the action asked be taken as a measure which will be approved by the great body of users and manufacturers of copper.

(Signed) CHARLES A. BROWN,
GEORGE M. PHELPS,
J. F. MORRISON.

The National Electric Light Association consists of corporations, firms and individuals owning and operating stations and plants for the distribution of light and power by electricity.

At the time of the last convention of the Association, August 6, 1889, the capital then invested in the industries above named was estimated, from statistics collected by the secretary of the Association, to be no less than $275,000,000. That sum represented mainly electrical apparatus and electric conductors for the supply of 238,000 arc lamps and 2,700,000 incandescent lamps, in all which apparatus and conductors copper is an indispensable and chief material. In the total cost of electric plant for light and power distribution, it is estimated, by competent experts, that from one-fourth to one-third is expended for copper.

The foregoing figures and statements sufficiently indicate the magnitude of the interest of electric light and power companies in the price of copper.

In the opinion of the petitioners the proposed abolition of the copper tariff does not touch the question of protection to American industry. The duty on copper appears to be wholly superfluous as a protection to American producers of that metal. The United States not only produces more copper than it consumes, and consequently exports that metal, but it possesses the richest and most easily worked copper mines in the world, and its mining companies produce the metal and put it in the market at a lower cost than is possible to the Spanish or Chilian miners. Obviously the American producers of copper require no duty to protect their domestic market; and their exports of copper furnish sufficient evidence of their ability to meet competition in foreign markets.

The existing duty is of no appreciable value to the national treasury, because copper is not imported in any considerable quantity. As a source of national revenue the copper tariff is practically useless, and the returns from it could not be increased materially under the conditions of production throughout the world by any modification of the rate of duty, if the government needed increased revenue, which it confessedly does not.

It would appear, therefore, that the duty on copper can only be efficient, in enabling the mining companies and dealers in copper to establish and maintain excessive prices through combination for that purpose. It is believed that the United States duty of four cents per pound was a considerable factor in the operations of the syndicate established in France in the autumn of 1887, and which syndicate, aided by its agreements and contracts with copper mining companies in this country, succeeded in controlling the copper production and markets of the world for more than a year, doubling, for a considerable period, in London and New York, the price existing just previous to the beginning of its operations. This was effected, moreover, in the face of an abundant supply of the metal. For some months after the breakdown of the French speculation, the American companies maintained the price in this country considerably in excess of that of European markets.

Touching the relation of the duty on copper to combinations for maintaining excessive prices, the following quotation is subjoined:—

Extracts from Editorial in New York *Tribune*, May 15, 1889.

The mine owners have publicly stated that they are able to produce more than all the copper this country consumes, and a large part of it at a cost not exceeding six cents per pound, and that they propose to the French bankers, who hold an enormous unsold stock to fix the selling price at about thirteen cents per pound—more than double the cost. Nothing need be said about the right of the producer to get a profit of more than 100 per cent. on his copper, provided he is not a beneficiary of a national policy intended to protect and encourage American production. But the mine owners are beneficiaries of that policy, and owe to the public a certain consideration and service in return. If they enter into a combination for the benefit of foreign speculators and bankers against the interests of American producers, the duty on copper may not last long. * * * There will in all probability be a revision of the tariff next winter. The party in power being anxious to defend all industries that need and merit defense, will for that very reason be more strongly pressed to cut off duties where no defense appears to be needed or where it seems to be not deserved. Combinations of speculators to corner the markets of the world are not highly popular, and will not appear to members of Congress to merit particularly favorable consideration. Under such circumstances the demand for a removal of all duties on copper ore, pig and bars, will be difficult to resist. It is safe to say that, had the Mills bill proposed no change more unpopular or unobjectionable than that, its public support would have been incomparably greater.

In short, and to recapitulate, in the opinion of the National Electric Light Association the duty on copper, being useless for revenue and unnecessary for protection, should not be suffered to remain on the statute books of the United States, since its only remaining function is to serve as an ally to the promoters of combinations for putting up prices, a process to which the government should not lend its assistance.

HOW TO BUILD A POLE LINE.

Mr. George F. Card, superintendent of the Cincinnati Electric Light Co., is building an overhead circuit that can be profitably copied by all new companies. Selected white oak hexagonal poles, that rise 40 feet clear of the sidewalk, are placed in narrow lodes 6 feet in depth, and the vacant space is filled in—not with dirt, but entirely with macadam. Wherever the solid stone flagging covers a section of the basement, no hole is made, other than four bolt holes, by means of which a tapering cast-iron thimble 4 feet in height and weighing 600 pounds is securely bolted to the sidewalk. The pole is placed within the thimble and the surrounding space filled with melted sulphur, which allows for any change of temperature as well as preventing the absorption of moisture. Thimble and pole are painted with two coats of a neat red color to a height of 6 feet, then a 12-inch band of black, and the remainder clear white. Heavy cross-arms having four, six or eight holes are used, double arms are placed at each turning point, while every cross-arm is double braced, and every corner pole strongly guyed with ⅜ inch galvanized steel rope and swivel turn buckle to a 10-foot oak post placed at an angle 8 feet in the ground. The pins are of split oak, the corner pins being bolted to the cross-arm, and all glass insulators are of the heavy double-petticoat deep groove form. No. 6 Simplex heavily insulated wire is now being strung, and where it comes nearer than 3 feet below the telegraph or telephone wires the latter are raised to the proper height, the respective company furnishing the poles and material and Mr. Card the necessary labor. General Hickenlooper instructed Mr. Card to spare no expense in constructing a strong, well-built line, of the best material that money will buy, in order that the company could once for all determine whether overhead circuits could be safely and economically operated, irrespective of what others may claim. Mr. Card said, in referring to underground systems: "In a short time we shall be carrying on a series of experiments to determine the best method of underground work, and we are perfectly willing and stand ready to place our wires underground the moment a safe, practical method is demonstrated." This overhead pole line is so perfectly constructed and so neat in appearance that the Board of Public Works approved the following report and recommendation: "The Committee on Light recommends that in the matter of erecting electric light poles on Fourth street the Cincinnati Electric Light Co. be authorized to proceed with the erection of poles under their permit and the ordinances, and that when said line of poles is erected, the Brush company be required to remove the poles now on Fourth street, and to occupy the line of poles of the Cincinnati Electric Light Co."—*Electrical World*, Feb. 1.

A WENSTROM DYNAMO TESTED AT JOHNS HOPKINS UNIVERSITY.

We have received a report of a series of tests of a Wenstrom dynamo, recently conducted at Johns Hopkins University, by Dr. G. A. Liebig, Dr. Louis Duncan and Mr. W. F. Hasson.

The dynamo was described by the manufacturers as an 800-light machine and was stated to absorb energy, when doing full duty, at the rate of about 60 h. p.

The following table gives the results of the several determinations :—

Current.	E. M. F.	Horse-power.	Dynamometer horse-power.	Loss. Δ	Losses, Friction, Reversals, etc.	Losses, Current^2 × Resistance.	Efficiency.
134.8	114.0	20.6	24.97	4.4	4.4	.17	82.5
194.1	115.6	30.1	35.3	5.2	4.5	.38	85.2
371.6	98.3	49.0	54.5	5.5	3.5	1.30	89.9
400.0	110.0	58.9	64.7	5.8	4.1	1.50	91.0

Speed of dynamo, "330" revolutions per minute.

A DINNER TO MR. E. H. JOHNSON.

A complimentary dinner was given by Mr. H. McL. Harding and Mr. J. L. Barclay, of the Sprague Electric Railway and Motor Co., to their former president, Mr. Edward H. Johnson, at the Hoffman House, Monday evening, January 20. A number of the gentlemen who had been Mr. Johnson's associates with the Sprague and with the Edison companies were present, including Honorable John H. Wise, Samuel Insull, J. H. Vail, S. Dana Green, H. W. Blake, F. J. Sprague, J. K. Muir, Frank Johnson, T. C. Martin, C. W. Price. Much good-fellowship prevailed, and all the gentlemen, in responding to toasts, expressed their esteem and respect for Mr. Johnson in flattering terms. Mr. Vail presented a series of complimentary resolutions on behalf of Mr. Johnson's associates and the employés of the Sprague company.

OBITUARY.

Austin Goodyear Day.

The death of Mr. A. G. Day, at South Poland, Me., December 28, last, takes from electrical manufacturing and trade circles one of their best known figures. Mr. Day was born in West Springfield, Mass., November 24, 1824. At the age of sixteen, with his cousin, Charles Goodyear,—who afterwards acquired fame and fortune in the india-rubber business,—he visited Northampton, where he first saw the process of manufacturing india-rubber goods. This incident determined his pursuit for life. Captivated with the business he soon went into Mr. Goodyear's service as correspondent and bookkeeper at his factory at Woburn, Mass.

Much of his time was spent in the study of india-rubber—its physical and chemical qualities, and the processes of its manufacture. He assisted in the vulcanization of the first two or three yards of sheet-rubber already being treated by Hayward for Goodyear.

He continued for several years in the service of Mr. Goodyear, instructing the workmen in the various factories set up, and conducting experiments in applying the process of vulcanizing to numerous articles. At the Roxbury factory he made the acquaintance of Professor Hayes, afterwards state assayer for Massachusetts, which proved of great value to him. It was under the general directions, and often the close inspection of the professor, that Mr. Day now prosecuted many of his experiments, with new ardor, with a view of discovering a substitute for sulphur. Although this object was not attained, his long and varied course of experiments, under the suggestions of Professor Hayes, were of the highest importance in their bearing upon his later discoveries.

It was during his experiments under Professor Hayes, in 1845, while vulcanizing rubber in melted sulphur, that he made many pieces of rubber of a hardness like horn.

In 1854 Mr. Day bought a factory in Seymour, Conn., where his manufacturing has since been continued without interruption. He early gave attention to the production of insulated wires and cables for the telegraph service, a branch of manufacture which, in recent years, has developed into the manufacture of a great variety of electric conductors, to meet the requirements of electric light and power distribution. Mr. Day's "kerite" insulation has made its way into all fields of electric work.

Long ago Mr. Day's health was impaired by excessive devotion to work and experimentation. Not long since he retured from an absence of some six years in Europe, whither he went for needed rest and recuperation.

SHIPS STRUCK BY LIGHTNING.

Up to 1820, when Sir W. Snow Harris commenced his agitation for the use of lightning conductors at sea, ships had practically been without any such protection. It is, therefore, not surprising to find, that in the course of about fifty years—from 1793 to 1840—over 200 ships had been struck by lightning. Between 1810 and 1815 the Royal Navy suffered severely, for damage was done by lightning to no fewer than 35 line of battle ships, 13 frigates, and 10 sloops. It was estimated that in 22 years from 1793 to 1815—the spars of all kinds shattered by lightning and rendered useless were worth about £72,000. In 1813 no fewer than five out of thirteen line of battle ships cruising off the Rhone were struck by lightning on the same night. In some of the old warships an unsuspected source of danger was often to be found. A capstan, having an iron spindle five feet long and six inches in diameter, was placed vertically over the magazine, immediately under which were long metallic bolts used in the construction of the ship, which passed through the keel into the sea. No arrangement could have been better provided to ensure an explosion. The Harris system of conductors entirely superseded the obsolete chains of Dr. Watson, which stretched from truck to water line when in use, but were more often stowed away. The following are a few instances of the damage caused by lightning to the old badly-protected wooden ships. In April, 1827, the American packet ship "New York," bound to Liverpool from New York, was struck when about 500 miles from the nearest American land. Her old-fashioned conductor was not aloft when she was first struck. Her conductor was then placed in position. It was composed of an iron terminal rod standing up from the royal truck about four feet, to which was attached an iron chain, which trailed in the sea. Again she was struck, and this time the conductor was fused and set the deck on fire, although at the time the rain was falling in torrents. In 1845 a Turkish vessel in the Baltic was struck. Her conductor was aloft, but was not in connection with the sea. A hole, similar to that made by a cannon ball, was made in her side. In 1820, the French corvette "Coquin" had a hole made in her bottom by a stroke of lightning in the Bay of Naples, and but for ready aid must have sunk at her anchors. Finally, the 74 gun ship "Cumberland" required three complete refits and two new mainmasts in the short space of 18 months owing to being repeatedly struck by lightning.—*Electrician* (London).

DEEP-SEA FISHING BY MEANS OF THE ELECTRIC LIGHT.

In the investigations that were undertaken by the Prince of Monaco, in deep-sea soundings an ingenious method was adopted to obtain specimens of the living creatures existing at the bottom of the ocean. The apparatus used was shown at the Paris exhibition. The cage in which the submarine animals were caught, according to *Le Genie Civil*, consisted of a cylinder of wire having three conical entrances, like those of a lobster pot, and weighted for submersion with detachable weights. It was, however, very unlikely that at these immense depths, where the darkness is practically total, any fish would voluntarily find their way into the trap, and steps were taken to attract them by a light placed nside it. Obviously, no light was available but an electric light; but to get an electric light to burn a mile or two under water was not easy. The only resource was to supply the incandescent wire from a battery in the trap. Here, however, another difficulty appeared. It was necessary to enclose the battery, which had to be of considerable power, in a box of some kind, and as the hydrostatic pressure at such depths was six or seven hundred pounds per square inch, it was found impossible to make a box which was not crushed before it reached its destination. At last, however, this trouble was overcome by the curious device of connecting the box with a balloon. The balloon was made of cloth dipped in india-rubber, and so arranged that the air in it was in communication with that in the battery box. On sinking the apparatus, the hydrostatic pressure, being virtually uniform all round the balloon, compressed it equally on all sides, forcing the air out of it into the battery box, until the pressure inside the box and balloon exactly balanced the pressure outside. This process went on to any extent, so that at the bottom of the sea, although the balloon was reduced by the enormous force exerted on it to a small fraction of its original size, it still kept the internal and external pressures equal. On raising the apparatus again it expanded as the pressure diminished, and brought the battery box to the surface uninjured. So successful was this device, that, not content with capturing deep sea fish, the Prince and his assistants propose on their next expedition to send down a photographic apparatus and bring back negatives of the bottom of the ocean, as seen by the electric light.—*Electrician* (London).

... ALTHOUGH it seems easy it is really not very easy to get into the way of using the centimeter (about two-fifths of an inch) as the unit of length.—*John Perry.*

CLUB NOTES.

New York Electric Club.—A Lecture by Professor Cross.

The monthly meetings of the Electric Club, during the fall and winter, have steadily increased in attendance and interest. The meeting January 16 was one of the most enjoyable of the year. The lecturer was Professor Chas. R. Cross, Professor of Physics in the Massachusetts Institute of Technology. The parlors of the club were filled by an appreciative and representative audience. The title of the lecture was the "Acoustic Principles Underlying the Art of Telephony," and set forth the several elements of the topic with completeness and entire lucidity.

Professor Cross is gifted with the ability to deliver an address or lecture untrammeled by manuscript or even notes, and he does it with no loss of clearness or continuity. The lecture was illustrated by apparatus brought from Boston. The lecture was followed by an interesting discussion, in which Professor Geo. Forbes, of London; Professor Le Conte Stevens, of Packer Collegiate Institute, Brooklyn; W. D. Sargent, John J. Carty, Thos. D. Lockwood, A. V. Garratt and others, took part. Professor Cross closed the discussion with some interesting references to the experiments of Helmholtz. A unanimous vote of thanks to the lecturer was given with enthusiasm before adjournment.

At the opening of the meeting, President O. E. Madden in the chair, some of the business matters of the club were presented. After the reading of the minutes of the previous meeting, which the secretary presented in rhyme, the president made a comprehensive statement concerning the financial condition of the club. His address was listened to very attentively, the whimsically entertaining manner in which he presented facts and figures causing several interruptions from enthusiastic applause.

President Madden said he was delighted at the large attendance of members and friends, and he took it not only as a fitting compliment to Professor Cross, who had come at great inconvenience to himself from Boston to interest and instruct; but he took it also as an evidence of the interest in the objects for which the Electric Club was established, and this argued well for its future prosperity and success. Continuing, he said: "Since the last regular meeting of the club, I have been called to the office of president by your board of managers, to fill the vacancy caused by the resignation of Mr. Gilliland. I am not unmindful of the honor thus conferred upon me, nor lacking in appreciation of the responsibility of the position. It shall be my aim and endeavor to advance the interests of the club in every way to the best of my ability. In this, however, I cannot hope for the greatest success unless I am assured of the co-operation of each and every member of the club, which I sincerely trust will be accorded to me."

The president then presented a statement of the club's financial affairs. While the showing, he said, indicated that the club needed, and would continue to need, the aid of its members, it proved that the club's finances were in much better condition than at any previous time, and expressed a very strong hope of being able soon to wipe out the floating debt, and at the same time to reduce the bonded debt.

Letters were read from the Sawyer-Man Electric Company, P. H. Alexander, general manager, and the United Edison Manufacturing Company, H. Ward Leonard, general manager, forgiving in each case the amount of their bills for labor and fixtures furnished the Electric Club, and each letter containing earnest wishes for the success of the club. The letters were received with hearty applause.

A cable message was also read from ex-president Henry C. Davis, of the club, who is now in London, in which he wished the club every success and accepted the proposition of the finance committee in settlement of his bill against the club for moneys advanced at the time the club house was fitted up, President Madden stating that General Manager G. G. Ward, of the Commercial Cable Company, had very kindly made no charge for the use of his line in sending and receiving messages. Attention was called to the fact that in several cases bondholders had signified their interest in the club by presenting the finance committee with their present holding of bonds, and that the first lot received was from the club's most distant member, John I. Sabin, of San Francisco, who presented the club with $250, accompanied by his best wishes, and this example the president thought it was hardly necessary to dwell upon.

After the adjournment of the formal meeting, an appetizing lunch, accompanied by Electric Club punch, was set out in the back parlor, and the 150 or more members and visitors present enjoyed a social re-union around the table. Music by Mr. W. S. Hine and Lieutenant F. W. Toppan, U. S. N., and recitations by Mr. John C. Tomlinson and Mr. Walter Pelham, added to the pleasures of the evening. It was the unanimous expression of the very large number present, that the meeting was one of the most agreeable in the history of the club.

Among those from a distance who were present were Professor Geo. Forbes and Sir John Swinburne, of London; Professor Le Conte Stevens, Brooklyn; F. W. Webster, T. D. Lockwood and C. J. H. Woodbury, of Boston; R. K. Steen, Wilmington, Del.; A. E. Powers and J. A. Powers, Troy, N. Y.

Among those from New York were C. O. Baker, Jr., Gen. C. H. Barney, G. B. Coggeshall, J. C. Chamberlain, E. A. Colby, E. W. Carritt, W. M. Clark, J. J. Carty, F. Gottschalk, M. W. Garver, A. V. Garratt, A. S. Hibbard, H. P. Hungerford, W. S. Hine, E. J. Hall, Jr., E. A. Leslie, O. E. Madden, H. B. Miller, F. C. Mason, F. C. Maguire, A. H. Patterson, E. F. Peck, W. S. Perry, J. C. Reilly, J. A. Seely, W. D. Sargent, H. L. Storke, J. H. Seymour, Lieutenant F. W. Toppan, J. C. Tomlinson, Dr. S. S. Wheeler, George Worthington, Jesse H. Bunnell, Jos. Wetzler.

A number of the officers and members of the American Society of Civil Engineers, which was in session in New York, were present by invitation, and were made at home by the members of the club. Among these were W. G. Worthen, of New York, and James B. Francis, of Lowell, both past-presidents of the society.

It was announced that the next regular meeting would be February 20th, at which time Honorable Grosvenor P. Lowrey, would deliver an address on "Patent Law, and What Constitutes an Invention."

Boston Electric Club.

The fourth annual dinner of the Boston Electric Club occurred January 6, at Young's Hotel, the new president, H. B. Cram, in the chair. In the after-dinner discussion, President Cram said he hoped, by free discussion and intelligent decision, to relieve the public mind from fear and anxieties which may arise in regard to the transmission of electrical energy. W. J. Denver, of the New England Telephone Co., said he was glad more attention will be paid to the discussion of electrical matters during the coming season. A great deal of talk will be made on Beacon Hill during the present session about electrical matters, which the average legislator but little understands. Efforts will be made to show how wires should be constructed and regulated, so as to be entirely safe. My idea is, he said, that the better way to do would be to allow that business to go as in the past, unhampered. If a sensible code of rules can be formulated we will all be willing to co-operate in any direction that is necessary in regard to safeguards. I have some appreciation of the tendencies to make injudicious laws.

Frank Ridlon said that the Boston Electric Club ought to be the instructor of the public of Boston on electrical matters in the future. We want no uninformed legislation, said he, but we do want legislation based on information.

W. A. Stiles, of the Thomson-Houston company, said:—"Whether justified or not, there is a general impression that the electric current going through the wires of the United States is not quite safe or comfortable." He suggested that it would be a good idea to ask the police and fire commissioners to a conference, and explain how, by the use of insulated pliers and rubber gloves, blockades of horse cars and possible injury to horses and perhaps men might be prevented.

Arthur Lord, of the Massachusetts civil service commission, thought there is a danger in too much legislation. He said that much of the success of electrical operations in the past has been due to the absence of restrictive legislation. If there is to be legislation it should be wisely considered, and should receive the approval of the men who have as much interest in the matter as any other members of the community.

Roman I. Zuboff, of Russia, said that Russia acknowledges its debt to America in electricity. One of the foremost electricians in Russia is a student of American electrical matters, and he lately proposed to the Czar an elevated electrical railroad from St. Petersburgh to Zaretzin, a distance of 2,000 miles.

George F. Meech, G. W. Mansfield and Dr. A. F. Mason spoke on the necessity for more education of the public mind on the question of electricity.

MANUFACTURING AND TRADE NOTES.

The Westinghouse Machine Company, of Pittsburgh, has received an order through its agency at Copenhagen, Denmark, for one of its now famous automatic compound engines. The size selected is 14 & 24 x 14, and it will be used at Kopparbergs Bergslaget at Falur, near Stockholm, Sweden. Large numbers of these engines are now being shipped to foreign countries.

Mr. John R. Tilley, who for several years past has represented British builders of machinery and steam engines at Demerara, British Guiana, has severed his British and Scotch engine connections, and has become the resident agent of the Westinghouse Machine Company, of Pittsburgh, for Demerara and the British West Indies.

Messrs. James Leffel & Co., Springfield, O., manufacturers of the celebrated "Old Reliable" water-wheel, and superior steam engines and boilers, have enjoyed a large trade throughout the season of 1889, and carry many orders over into the new year. They are now running their works until 10 o'clock at night in order to meet the steadily increasing demand for their specialties.

"**Cleverly**," 1018 Chestnut street, Philadelphia, adds to his line of electrical apparatus for domestic uses, including call-bells, annunciators and gas lighting appliances, a "pendant burner," having a double lift-over electrode, which is claimed to increase the efficiency and economy of electric gas lighting and to avoid short circuiting.

Mr. D. H. Edgerton, of Philadelphia, has established and equipped a shop and laboratory for electrical experimentation, at 805 Sansom street, equipped with facilities for careful investigation, as well as for manufacture and repair. Mr. Edgerton has under his control, at his place, both high and low tension direct currents, and the alternating current, covering a range and variety of current supply for electrical work sufficient for all ordinary demands of experimentation. Mr. Edgerton is well known as a manufacturer of motors.

The Riker Electric Motor Co., manufacturers of dynamos, motors and specialties in motors, 45 and 47 York street, Brooklyn, N. Y., call attention to their latest type of dynamos and motors. The Riker machines have been well known for a long time, and in the new type simplicity of mechanical device and construction, with diminished cost of manufacture have been sought. The Riker company particularly point out the low armature bearing, insuring minimum vibration and diminished noise in running, the distribution and fine grade of iron used, and the distinctiveness and general beauty of design.

The Okonite Co., New York, with its usual enterprise will be on hand at the electric light convention at Kansas City, showing a full line of its "Okonite" wires, cables and tapes. The watchword of this concern is "Forward" and their business activity and position in the electrical trade shows it to be thoroughly lived up to.

The Standard Underground Cable Company's annual meeting of stockholders was held in Pittsburgh, January 23d, and a meeting of directors on the succeeding day. All the old officers were re-elected, viz:—George Westinghouse, Jr., president; C. H. Jackson, vice-president and general manager; John H. Dalzell, treasurer; J. W. Marsh, secretary; Elmer L. White, auditor and assistant treasurer. The following directors were elected:—George Westinghouse, Jr.; Robert J. Pitcairn, Caleb H. Jackson, Mark W. Watson, John H. Dalzell, Joseph W. Marsh, Henry Snyder.

A very favorable report of the year's business was submitted, indicating a net profit of 11 per cent. on the par value of the capital stock. The company starts upon the new year with orders in hand aggregating nearly $150,000. A dividend is announced for April 1st.

Messrs. Garvin & Co. have recently introduced a new die grinder, designed particularly for use in connection with punch presses for grinding and sharpening dies, punches, etc., and for general use as a small surface grinder. The slide is traversed by hand by means of a lever, making a simple machine. The spindle has a vertical screw adjustment, and ample room is provided for running wheels of large diameter. The plan of belting this machine puts a loop in belt, which allows belting direct and dispenses with a tightener. The table has a transverse screw adjustment, and is provided with T slot for holding work. Surface can be ground at one setting, 6 inches by 6 inches. The machine weighs complete 350 pounds.

ELECTRIC STREET RAILWAYS.

Boston:—President Henry M. Whitney, in speaking of the plans of the West End Street Railway Co., says that the company has bought the property in Cambridge of the New England Glass Co., where it intends to place its power plant for the operation of electric cars in Cambridge, Charlestown and Somerville. The property is well adapted for immediate use, as there is a large chimney sufficient for 6,000 or 7,000 h. p., buildings suitable for engines and boilers, and a wharf for landing coal. The company has already contracted for about 2,000 h. p. in engines to be placed in this power house, which will be sufficient for immediate needs, and hopes to have the plant in operation early in the summer.

The directors have recently authorized the purchase of 200 open cars, thereby adding nearly 25 per cent. to the open car equipment, and are expecting to contract for a large number of additional box cars, to be ready for another winter. The growth of the passenger business is so rapid that it is difficult for the company to provide equipment rapidly enough to meet the demand. The number of passengers carried per day averaged for each day in December nearly 50,000 a day more than in 1887.

"So far as I am able to judge from expressions of opinion by all communities that are now reached by the electric cars," said Mr. Whitney, "the electric system is giving excellent satisfaction, and we are solicited to extend the system from all quarters. The lines from Park Square to South Boston and from Egleston Square to Forest Hills will be among the first to be equipped the coming year. The Egleston Square line itself will probably be opened between this and the 1st of February."

These statements by President Whitney show that the company is making great preparations to meet the extraordinary increase of business, and when the new tracks are laid and the electric system is extended the public will be able to judge fairly in regard to the merits of the system. It is said that the plan which the directors of the road have in view for the relief of travel in the crowded streets of the city proper is an elevated railroad—a scheme which has in the past met strong opposition.

The Thomson-Houston Electric Co.'s railway list of December 15, 1889, shows on that date 47 street railways in operation, equipped with their system, comprising 335.75 miles of track and 525 motor cars; in addition three Thomson-Houston cars were running on roads equipped with other systems.

At the same date the Thomson-Houston Company had under construction or contract, 34 roads with 451 miles of track and 511 motor cars. They had in hand orders from roads then in operation for additional equipment as follows:—25 motor trucks and 90 motors.

The Sprague Electric Railway and Motor Co. report the following recent orders for street railway equipment:—Davenport, Ia., Davenport Electric Street Railway Co., 4 cars; Dubuque, Ia., Electric Light and Power Co., 10 cars; Chicago, Ill., Cicero and Proviso Street Railway, 12 cars.

They report also the following additional orders from street railway companies already equipped with Sprague or other systems:—Sioux City, Ia., Sioux City Electric Railway, 3 cars; Milwaukee, Wis., West Side Street Railway, 9 cars; Des Moines, Ia., Des Moines Electric Railway, 2 cars.

The Sprague company has made several contracts to supply its motors and railway apparatus for use in foreign cities. Now comes a contract for a railway in Japan. Through arrangements made by its agents in that country, Messrs. Everett, Frazar & Co., the Sprague company has already commenced construction upon a railway line in Tokio, and it will not be long before the road will be in operation. The first shipment to this distant point includes two electric cars, fully equipped with Sprague apparatus, with full station and line equipment for a complete installation. It is said that this shipment will soon be followed by other and more extensive shipments, and that an extensive street railway line will at no distant day be in operation in Tokio on the Sprague system.

The Sprague Electric Railway at Moline, Ill., is now in successful operation.

Chicago capitalists are negotiating for the purchase of the Belle City street railway, of Racine, Wis. If it is bought, electric motors will be substituted for horses.

A contract has recently been closed for an electric railway at San Jose, Cal., which is the first Thomson-Houston road in the state. One electric railway has already failed in that city. The Thomson-Houston Electric Co. will introduce its latest and most improved apparatus. Ornamental double bracket iron poles will be used, and nothing will be left undone to make the road a model one in every respect.

ELECTRIC LIGHT AND POWER.

The Lafayette Car Co. has decided to install an electric lighting plant for the illumination of their extensive buildings and yards at Lafayette, Indiana. The order was placed with the Heisler Electric Light Co., of St. Louis, and prompt shipment required. The apparatus was shipped from St. Louis on the day following the receipt of the order.

The Rawson and Root Lumber Co., of Michigan City, Ind., which has been operating a Heisler electric lighting plant for about a year, has contracted to furnish a large number of lights to the furniture manufacturers, whose works are run in connection with the Northern Indiana State Prison. To carry out this contract, an order has been placed with the Heisler Electric Light Co., of St. Louis, for one of their largest dynamos, with the necessary lamps, sockets, etc. The new apparatus is to be in operation before the middle of November.

The Westinghouse Electric Company will remove its works from Pittsburgh. It will erect, as soon as possible, new and much larger factories near Brinton, on the main line of the Pennsylvania Railroad, about twelve miles from Pittsburgh.

This removal is deemed advisable by the directors of the company on account of lack of sufficient space in the present works, and the great cost of enlarging the premises now situated in the heart of the city. The present buildings are to be sold and will, it is thought, yield $500,000. This money will be used in the construction of the new shops, which will occupy a plot of fifteen acres. It is the purpose of the Westinghouse Electric Company to lay out and build up a new borough surrounding the plant, as is being done at Wilmerding, several miles distant, where the new Westinghouse air-brake works are nearing completion. The Electric company since a year ago has increased the number of its workmen from 600 to 1,300, and these, with their families, will give the new town a population of about 5,000. The new town will have connections with the Pennsylvania and with the Vanderbilt systems of railroads.

The record of the progress of the Westinghouse Electric Company during the year 1889 is very remarkable, even in these days of astonishing developments in electrical industries. On the first of January, 1889, 132 central station plants had been sold by the company, aggregating a capacity of 240,000 lamps. The number of central station plants has now reached 266, with an aggregate capacity of nearly 500,000 lamps.

Meantime the absorption of the Waterhouse arc light business, the manufacture of the Shallenberger alternate current meter, Tesla motor work, and other additions to the original undertaking, compelled large additions to the Pittsburgh shops and the removal of the lamp factory to New York. The number of employés at Pittsburgh grew from 600 to 1,400. Available space being now exhausted the company wisely adopts, for the removal of its works, a suburban locality which will permit of indefinite expansion of factory room in the future.

The Ocean Grove Camp Meeting Association (Ocean Grove, N. J.), have arranged to greatly enlarge their electric lighting plant between now and next spring, and have contracted with the Heisler Electric Light Co., of St. Louis, for two of their largest dynamos. The previous orders of this association covered four Heisler dynamos.

The New York, Lake Erie and Western Railway Co. has introduced electric motors in place of mules for traction purposes in its mines. An electric motor has been set at work in the company's Hillsdale coal mine, near Forest City, Pa. It is stated that the motor will make the round trip from the coal breaks to the breaker in six minutes, hauling 30 cars. It required nine mules to draw the train at one-quarter the speed. By using the electric motor the company saves $25 per day on the cost of power, and is enabled to increase the output of the mine from 1,000 to 1,500 tons per day.

Mr. Charles Heisler, the founder of the Heisler long-distance lighting system, has recently returned to St. Louis from Paris much gratified by his success in carrying off a gold medal from the Jury of the Exposition of last year. He is much improved in health, but not yet ready to re-enter active business.

The Thomson-Houston Electric Co. report the following sales, with the number of lights in each case.

Incandescent apparatus for central stations :—

Franklin, Tenn., 300; Northampton, Mass., 650; Chatham, N. Y., 650; Beverly, Mass., 650; Great Falls, N. H., 1,300; Punxsatawney, Pa., 650; Sandy Hill, N. Y., 650; Petulama, Cal., 650; Muscatine, Ia., 650; Battle Creek, Mich., 650; Langhorne, Pa., 500: Belfast, Me., 300; Auburn, N. Y., 1,300; Meriden, Conn., 1,300; Paris, Ky., 1,300; Loug Branch, N. J., 650; Jacksonville, Fla., 650; Wallace, Idaho, 650; Millbury, Mass., 650; Brandon, Vt., 650; Butte, Mont., 650; Springfield, Ill., 650; Fresno, Cal., 650; Nashville, Tenn., 2,600; Ann Arbor, Mich., 650; Watsonville, Cal., 300; Mt. Clemens, Mich., 650; Bozeman, Mont., 500; Spokane Falls, W., 300; Great Falls, Mont., 650.

Arc apparatus for central stations :—

Franklin, Tenn., 20; Butte, Mont., 30; Rochester, N. Y., 105; Kokoma, Ind., 70; Bedford, Ind., 50; Long Branch, N. J., 100; Wilkesbarre, Pa., 50; Lowell, Mass., 25; Atlanta, Ga., 50; W. Superior, Wis., 50; Martin's Ferry, Ohio, 20; Johnstown, Pa., 50: Hyde Park, Mass., 50; Spokane Falls, W., 50; Petulama, Cal., 50; Omaha, Neb., 100; Denver, Col., 70; Richmond. Mo., 15; Joliet, Ill., 35; Nashville, Tenn., 300; Mt. Clemens, Mich., 30; Cheboygan, Mich., 30; Bluffton, Ind., 50.

Arc apparatus for isolated plants :—

Mayfield Woolen Mills, Mayfield, Ky., 200; Western Kentucky Lunatic Asylum, Hopkinsville, Ky., 300; W. Russell & Co., Bellows Falls, Vt., 50; L. C. Bass Mfg. Co., Guilford, Me., 100; Portland Steam Packet Co., Portland, Me., 400; Wayside Knitting Co., Troy, N. Y., 200; Carrollton Furniture Co., Carrollton, Ky., 150; Morgan Envelope Co., Springfield, Mass., 100; Cambridge Training School, Cambridge, Mass., 200: American Net & Wire Co., Cambridge, Mass., 200.

Incandescent apparatus for isolated plants :—

Maryland Pavement Co., Baltimore, Md., 9: Alliance Street Railway Co., Alliance, O., 50; Philadelphia & Reading Coal and Iron Co., Pottsville, Pa., 30; St. Paul Foundry Co., St. Paul, Minn., 9.

At Newport, R. I., the Jarvis Engineering Co., of Boston, are actively engaged in the alteration and enlargement of the plant of the Edison Illuminating Co., of that city. This company, since its organization, has met with remarkable success. Their new plant, as enlarged, has been designed by Mr. John Whipple, Jr., general superintendent, with a special view to the most economical production of the steam power. The steam battery consists of four horizontal tubular boilers, set with the Jarvis patent furnace to burn the cheap grades of fuel. Power for the dynamos is supplied by eight Armington & Sims engines, of their improved pattern, aggregating 850 h. p., and, by direct belting, saving the expense and loss of power from the use of shafting. The exhaust steam from the engines is passed through a National heater, and utilized to heat the feed water before it enters the boilers up to a temperature of 212 degrees.

The Suburban Light and Power Co., of Boston, which has been awarded the contract for the city lighting, has leased the building on Howard street, Roxbury, formerly used by the Globe Nail Works as a rolling mill. It is of brick, 175 x 76 feet, and contains a 600 h. p. engine. The company's contract with the city calls for about 800 lights, and this building is said to be ample to accommodate machinery and apparatus far in excess of immediate requirements, and to permit of a large extension of business.

The Beatrice Electric Light Co., Beatrice, Neb., under date of January 6, 1890, issues the following notice :—

"We desire to call your attention to the fact that we have no connection whatever with the 'Beatrice Electric Co.,' nor the 'Beatrice Electric Manufacturing Co.' We are engaged in the arc and incandescent lighting business exclusively, and have no other business whatever.

"We deem this explanation necessary, as some confusion has already arisen from the similarity of names."

The Crocker-Wheeler Electric Motor Co. have put upon the market a complete electric pump; motor and pump being mounted on one frame and connected by spar and pinion gear. The motor is of one-eighth horse-power, and the capacity of the outfit (made for either constant current or constant potential circuits) is given as equal to lifting 1,000 gallons of water per day to a height of 100 feet.

Whipple's Electrical Report for January, 1890, shows a total number of central electric light stations in the United States of 1,265. The number of gas companies given is 981, and of these 237 operate electric light plants in conjunction with their gas business. The number of electric railways in operation or under construction is 162.

The Pennsylvania Railroad Company, having decided to increase the capacity of the electric lighting plant at their main offices in Fourth street, Philadelphia, have shifted their storage batteries to the forward part of the building, in order to utilize the old battery room in the rear for a Corliss engine, to be used as an auxiliary to their present power plant. The Electro-Dynamic Co. has been awarded the contract for making the necessary alterations in the battery plant, switches, wiring, etc. The system will be changed from 60 to 100 volts, the present capacity of the plant being about trebled. The original wiring by the Electro-Dynamic Co., for 1,200 lights, is ample for the additional requirements.

The Edison Down-town Station, Pearl street, New York, destroyed by fire on the morning of January 2d, was rebuilt and running January 13th. To replace the burned station required an immense amount of work, and H. J. Smith, the superintendent, and John I. Beggs, the general manager of the station, got very little sleep while the reconstruction was going on. The old station contained eight dynamos, six being on the first floor of No. 257, and two on the first floor of No. 255 Pearl street. The fire in the buildings broke out at two o'clock in the morning, and at eleven o'clock the same morning Mr. Smith had the auxiliary station in Liberty street, which has a capacity for supplying 5,000 lamps, in full operation. Before the débris in the burned building had become cool, a number of men were put at work, and from that time until the night of January 11th a force of 100 men were at work day and night clearing out the ruins and building a new station.

The building No. 255 was first cleared out down to the cellar. On the floor of the cellar a crib, formed of 14-inch square yellow pine timbers, 28 inches high, was built, one course of timber being laid across the building, and the second course running lengthwise. The interstices between the timbers were filled in with concrete, and on the new flooring thus laid four new engines and eight new dynamos were placed. These have been running at full force since the morning of Monday the 13th. The steam pressure is supplied from the four old boilers in the building No. 257, which, upon examination, were found to be in good condition, although new steam pipes and connections had to be supplied. From this station 19,000 incandescent lamps are now supplied with power. A new flooring was put in at the level of the second floor of No. 255, and ten feet above this a temporary roof has been built.

This station will be used until the company builds its new down-town station, work on which will begin early next spring, to be completed before the end of the year. The new station will be just above the bridge approach, and will be strictly fireproof. It will have a capacity for supplying 100,000 lights, and will furnish power to all the part of the city south of Canal street. The station is planned for 25 engines and 50 dynamos.

THE BRUSH ELECTRIC COMPANY'S STOCK.—The following paragraph was telegraphed from Cleveland, Ohio, January 20, and printed in New York newspapers.

"There was more excitement at the annual meeting of the stockholders of the Brush Electric Company, which was held to-day, than was anticipated by those who held a majority of the shares. Several months ago a controlling interest in the Brush plant was sold to the Thomson-Houston Company, of Boston, but the sale has not been closed entirely. There were 40,000 shares in the company before it was sold, and the Boston corporation bought in all 30,000 of them.

"George W. Stockly, James J. Tracy, Gen. M. D. Leggett, C. F. Brush, and Mrs. John Carr, controlled the Brush company. At the meeting to-day many of the minority stockholders were present with their attorneys. A written protest representing 3,562 shares of stock was presented and spread upon the minutes. It set forth that inasmuch as the majority stockholders had received $25 per share premium for the 30,000 shares sold to the Thomson-Houston company, or $750,000, the "bonus" should be divided pro-rata among all the shareholders.

"The stock is in shares of $50 each, which, at the time of sale, were quoted at $35. Messrs. Stockly, Tracy, and their party sold their holdings to the Boston company at $75 a share. There was considerable discussion among majority and minority stockholders, but no settlement of the controversy was effected."

THE LOWELL ELECTRIC LIGHT CO. will make an extensive rearrangement of their plant. By reason of their contract with the Lowell and Dracut Street Railroad Co. to furnish power for moving street cars, the Electric Light Co. is obliged to seek larger quarters. A lot of land 160 x 300 feet has been purchased, and the company will erect thereon a commodious brick building. Their plant will be arranged by the Thomson & Houston Electric Co. Work will be begun immediately. The location is near the Lowell and Andover section of the Boston & Maine Railroad, which is convenient for the reception of coal. It is favorably situated for the distribution of light and power. By contract with the city and merchants, 530 arc lights are furnished and 600 incandescent. The company's steam plant, now of 1,000 h-p., will be largely increased. The company, originally the Middlesex Electric Light Co., organized under the laws of the State of Maine, absorbed the Lowell Electric Light Co., and about a year ago reorganized under the laws of Massachusetts with the last-mentioned title. W. A. Ingham is president.

THE BRUSH alternating incandescent plant at Barrie, Ont., which has been under construction by Mr. Lawson, of Montreal, for some time past, has been put into operation, and gives such satisfaction that the demand for service has already exceeded the company's expectations, 800 lamps being now connected—some 200 more than originally provided for. The Barrie company has, therefore, ordered additional plant for 1,000 lights. This installation is remarkable as being the only one in Canada using 2,000 volts in the primary wires, which is reduced to 100 on the lamps, Special insulation is used throughout. A water power, five miles from town, drives the dynamos.

LEGAL NOTES.

THE DECREE IN THE DOUBLE-CARBON ARC LAMP CASE OF THE BRUSH ELECTRIC CO. vs. THE FORT WAYNE ELECTRIC LIGHT CO. AND OTHERS.

UNITED STATES CIRCUIT COURT, DISTRICT OF INDIANA.

Present:—Honorable Walter Q. Gresham, Circuit Judge.

The Brush Electric Co. *vs.* The Fort Wayne Electric Light Co., Henry G. Olds, Perry A. Randall and Ranald T. McDonald.	*In Chancery.*

This cause having been brought to a final hearing upon the pleadings and proofs, and having been argued by counsel for the respective parties, and the same having been duly considered by the Court, it is found and hereby ordered, adjudged and decreed by the Court as follows, to wit:—

1. That the following letters patent of the United States, viz.: Letters Patent, No. 219,208, granted to Charles F. Brush, September 2, 1879, for improvement in electric lamps, is a good and valid patent. That said Charles F. Brush was the first and original inventor of the improvements and inventions described and claimed in said Letters Patent, No. 219,208, and that the complainant herein became and is invested with the exclusive right, title and interest in and to said letters patent, as in said bill of complaint alleged.

2. That the said defendants, the Fort Wayne Electric Light Co., Henry G. Olds, Perry A. Randall and Ranald T. McDonald, have infringed said Letters Patent, No. 219,208, granted to the said Charles F. Brush, by manufacturing and selling arc electric lamps embodying the improvements set forth and claimed in the first, second, third, fourth, fifth and sixth claim of the said letters patent, and that said defendants have violated and infringed the exclusive rights of the complainant secured to it by the said letters patent, in the manner set forth and shown in the pleadings and proofs in said cause.

3. That the said complainant is entitled to a discovery and accounting from said defendants of the gains, profits, benefits and advantages had and received by the said defendant, or either of them, as well as an accounting of and for such damages as the said complainant may have sustained through and by the acts of the defendants or either of them, and that the complainant recover said gains, profits, benefits and advantages which the said defendants have received, or which have secured to the said defendants, or either of them, from and by the aforesaid infringement of said Letters Patent, No. 219,208, by the manufacture, use or sale of the improvements therein described and secured by the first, second, third, fourth, fifth and sixth claims thereof, or any of them, and such further damages as the said complainant may have sustained by reason of such infringement.

4. That this cause be referred to W. P. Fishback, a Master in Chancery of this Court, to take proofs and report to the Court an account of the gains, profits, benefits and advantages which the said defendants, or either of them, have received, or which have arisen or accrued to them, or either of them, from infringing the exclusive rights of the said complainant by the manufacture, use or sale of the said improvements, patented in said letters patent, as, or substantially as described and secured, for the first, second, third, fourth, fifth and sixth claims thereof, or any of them; and also to state and report an account of the damages which the said complainant has sustained by said infringement.

5. And it is further ordered, adjudged and decreed that the said Master is hereby authorized to summon the defendants, their agents, employés, before him, as well as the officers and directors of the defendant corporation, and to examine them on oath; and to require the said defendants to produce their books, vouchers and documents touching the matters herein referred to; that the proofs already taken or used in this cause may be used on said reference, and that such other testimony may be taken before the Master, as is authorized by law and the rules of Court, as either party may desire and said Master may direct.

6. And it hereby ordered, adjudged and decreed that the said defendants, the Fort Wayne Electric Light Co., Henry G. Olds, Perry A. Randall and Ranald T. McDonald, together with the officers, successors or assigns, agents, attorneys and employés of the defendant corporation, be, and they hereby are, perpetually enjoined and restrained from making, using, selling or vending any arc electric lamps in which two or more pairs of carbons are independently adjusted and regulated by one and the same regulating mechanism, and are separated and burned successively

to secure the continuous burning of one pair of carbons prior to the establishment of the arc between the other pair, substantially as described in the specification and claimed in the first claim of said Letters Patent, No. 219,208, and also for making, using, selling or vending any electric arc lamps containing the invention, or inventions, substantially as described in the specifications, and claimed in the second, third, fourth, fifth or sixth claims, or any of said claims in said patent, No. 219,208, or any imitation, or substantial equivalent thereof, constructed substantially as described in said specification, and as claimed in that said first, second, third, fourth, fifth or sixth claims, and that an injunction issue forthwith accordingly. And it is further ordered, adjudged and decreed that the defendants pay the cost herein to be taxed, and that the complainant have execution therefor.

(Signed) W. Q. GRESHAM.

January 13, 1890.

BRUSH-SWAN vs. BRUSH.

Judge Coxe of the United States Circuit Court, January 17, filed a decision in the important suit of the Brush-Swan Electric Light Co., of New England, against the Brush Electric Co. The action was brought to compel the specific performance of contracts between the parties and for an injunction and accounting. The Court holds the contracts to have been of such a character that their performance by the defendant cannot be specifically enforced; but the injunction prayed for, restraining the defendant from selling electrical dynamos and apparatus in New England, the territory assigned by the contracts to the complainant, is granted, with a decree for an accounting of the profits.

Judge Coxe adds that the injunction should not interfere with any existing contracts made by defendant with third parties, or restrain the defendant from furnishing supplies and apparatus for established plants.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From December 17, 1889, to January 7, 1890 (inclusive).

Alarms and Signals:—*Watchmen's Electric Time Detector*, H. L. Norton and F. W. Cook, 417,501. *Electric Semaphore Setting Apparatus*, F. Stitzel, 417,525; F. Stitzel and C. Weinedel, 417,526, December 17. *Electric Signal System for Letter Boxes*, G. L. B. Rounseville, 418,322, December 31. *District Telegraph Alarm Box*, C. G. Armstrong, 418,778. *Annunciator*, J. Finck, 418,868. *Electrical Signal-Operating Device*, C. A. Cox and J. F. Cox, 418,910, January 7.

Clocks:—*Time-Distributor for Electric Clocks*, L. H. Spellier, 417,753. *Automatic Electric Clock-Winding Device*, F. A. Lane, 417,927. *Electric Winding Clock*, same, 417,928. *Electric Synchronizing Device for Clock Pendulums*, J. Hamblet, 418,125, December 24. *Electro-Mechanical Time Stamp*, C. A. Randall, 419,068, January 7.

Conductors, Conduits and Insulators:—*Electrical Conductor*, U. H. Balsley, 417,402. *Combined Support and Safety Device for Overhead Conductors*, R. A. Morgan, Jr., 417,497. *Conduit for Electrical Conductors*, J. Tatham, 417,688, December 17. *Underground Electric Conduit*, J. Dell, 417,992, December 24. *Insulating and Waterproofing Composition*, A. E. Menuez, 418,208, December 31. *Bracket for Supporting Electric Conductors*, J. A. Duggan, 418,704. *Support for Electric Conductors*, J. B. Smith, 418,766. *Insulating Nippers*, F. M. Casey, 419,111, January 7.

Distribution:—*System of Electrical Distribution of Currents*, C. J. Van Depoele, 417,654, December 17. *Generation and Distribution of Electric Currents*, F. J. Patten, 418,652. *System of Electrical Distribution*, same, 418,653. *Distribution of Electric Currents*, same, 418,655, December 31. *Distribution of Electricity by Secondary Batteries*, G. B. Prescott, Jr., 418,748. *Method of Transforming and Utilizing Electrical Energy*, M. W. Dewey, 418,912, January 7.

Dynamos and Motors:—*Automatic Regulator for Dynamos*, C. D. Jenney, 417,487, December 17. *Armature for Electrical Machines*, A. Schmid, and N. Tesla, 417,794. *Magneto-Electric Machine*, W. Gillett, 418,120, December 24. *Electro-Magnetic Motor*, N. Tesla, 418,248. *Armature for Dynamos*, J. J. Wood, 418,301. *Automatic Regulator for Dynamo-Electric Machines*, same, 418,302. *Current Regulator for Dynamo-Electric Machines*, same, 418,303. *Electric Motor*, J. J. Patten, 418,654. *Dynamo Electric Generator*, W. Stanley, Jr., 418,659, December 31. *Electric Switch for Motors*, H. H. Blades, 418,678. *Brush-Holder for Dynamos*, P. Claus and E. Gengenbach, 418,685. *Electric Motor or Generator*, I. E. Storey, 418,853. *Electric Motor*, H. B. Niles, 419,059, January 7.

Galvanic Batteries:—*Galvanic Battery*, E. A. Sperry, 417,290. *Treatment of Porous Pots for Electric Batteries*, E. L. Mayer and H Liepmann, 417,392. *Manufacture of Porous Pots for Electric Batteries*, same, 417,436. *Galvanic Dry Element*, C. H. Wolff, 417,458, December 17. *Galvanic Battery*, P. B. Delany, 417,814, December 24. *Battery Carbon*, C. G. Armstrong, 418,837, January 7.

Lamps and Appurtenances:—*Arc Lamp*, J. F. Shawhan, 417,516. *Ceiling Plate for Electric Lights*, H. H. Sawyer, 417,685, December 17. *Incandescent Lamp Socket*, J. W. Packard, 417,787 and 417,788. *Incandescent Electric Lamp*, same, 417,789, December 24. *Combined Gas and Electric Light Fixture*, D. J. Braun, 418,270. *Incandescent Electric Lamp Socket*, F. Thone, 418,426. *Electric Arc Lamp*, J. H. Bunnell, 418,444. *Electric Light Carbon*, L. Saunderson, 418,474. *Electric Light Fixture*, G. C. Baillard, 418,636, December 31. *Electric Arc Lamp*, C. E. Scribner, 418,757. *Incandescent Lamp Holder*, I. Storey, 418,855. *Electric Arc Lamp*, E. C. Russell, 418,987, January 7.

Measurement:—*Electric Meter*, C. A. Pratt, 418,472; A. J. Frager, 418,559, December 31.

Medical and Surgical:—*Electro-Therapeutic Apparatus*, F. J. Kneuper, 417,923, December 24. *Electric Belt*, C. H. Grimley, 419,018, January 7.

Metallurgical:—*Process of Extracting Gold and Silver from their Ores*, H. F. Julian, 418,134, December 24.

Metal Working:—*Method of Making Collars on Axles by Electricity*, H. Lemp and E. Thomson, 418,198, December 31. *Method of Welding by Electricity*, C. L. Coffin, 419,032. *Method of Electric Welding*, same, 419,033, January 7.

Miscellaneous:—*Electrical Apparatus*, C. D. Baker and L. G. Bronson, 417,217. *Electric Circuit*, J. C. Wilson, 417,304 and 417,305. *Electric Stenographic Pen*, A. S. Cooper, 417,407. *Electric Fan*, P. Diehl, 417,474. *Method of Regulating the Tension of the Electric Current*, C. Dihlmann, 417,668, *Musical Instrument*, R. W. Pain, 417,690. *Lightning Arrester*, P. Winsor and A. Wurts, 417,694; P. Winsor, 417,695, December 17. *Electric Cam*, H. S. Prentiss, 417,742. *Automatic Circuit-Closer*, J. Von der Kammer, 417,758, *Device for Demagnetizing Watches*, F. J. Whiton, 417,763. *Electric Circuit Controller*, F. A. Lane, 417,926. *Magnetic Toy*, G. W. Miatt, 417,931. *Magnetic Rubber Stock Cleaner*, N. C. Mitchell, 418,041. *Electrical Toy*, H. G. Rogers, 418,069; H. G. Rogers and A. M. Coyle, 418,070. *Automatic Vending Machine*, H. G. Rogers, 418,071, December 24. *Electric Exercising Machine*, E. W. Robinson, 418,227. *Lightning Arrester*, E. Thomson, 418,249. *Machine for Beveling Stereotype and Electrotype Plates*, J. Manning, 418,292. *Type-Setting Machine*, J. B. Odell, 418,321. *Screw Cleat for Electric Wires*, G. E. Huff, 418,369. *Method of Finding the Positions of Distant Objects*, B. A. Fiske, 418,510. *Apparatus for the Manufacture of Gas*, M. C. Burt, 418,550. *Apparatus for the Manufacture of Gas by Electricity*, same, 418,551. *Process of Electroplating Dental Plates*, J. G. Ward, 418,662. *Electro-Magnetic Type-Setting Machine*, W. Dreyer, 418,664, December 31. *Lightning Arrester*, E. A. Sperry, 418,824. *Carrier System*, I. E. Storey, 418,856. *Electrical Indicating Apparatus*, G. A. Holt, 418,871. *Electric Deep Sea Sounder*, A. J. Cooper and E. E. Wigzell, 418,889. *Electro-Magnetic Transmitter*, J. T. Williams, 419,166. *Electric Pen Holder*, C. W. Reitler, re-issue, 11,058, January 7.

Railways and Appliances:—*Electrically Propelled Vehicle*, W. Main, 417,259. *Method of Operating Electric Railways*, E. E. Ries, 417,338. *Train Signal*, D. S. McElroy, 417,438, December 17. *Device for Suspending Electric Conductors*, S. H. Short, 417,747. *Device for an Electric Car-Signal*, J. P. Runkel, 417,842. *Electric Heating Apparatus for Electric Railways*, R. M. Hunter, 417,920. *Motor Truck*, E. Peckham, 417,937. *Vehicle Motor Gear*, same, 417,938. *Electric Railway Contact*, F. O. Blackwell, 417,974, December 24. *Electric Railway Signal*, E. C. Wiley, 418,258. *Electric Railway*, H. W. Libbey, 418,373. *Electric Brake Mechanism for Cars*, W. H. Darling, 418,402, December 31. *Means for the Electric Propulsion of Vehicles*, D. E. Johnson, 418,843. *Cable Railway Signal*, J. H. Pendleton, A. Bryson, Jr., and C. Tiers, 418,850. *Electrically Propelled Vehicle*, R. M. Hunter, 418,893. *Electric Heating Apparatus for Electric Railway Systems*, M. W. Dewey, 418,911. *Apparatus for Propelling Vehicles by Electricity*, F. Wynne, 419,094, January 7.

Secondary Batteries:—*Secondary Battery*, J. W. Swan, re-issue, 11,047, December 17. *Electrode for Secondary Batteries*, H. G. Osburn, 418,140, December 24. *Secondary Battery*, A. E. Woolf, 418,483, December 31; H. E. Dey, 418,700. *Cut-Out for Secondary Batteries*, same, 418,701 and 418,702. *Method of Making Secondary Battery Plates*, same, 418,703, January 7.

Telegraphs:—*Quadruplex Telegraphy*, C. L. Healy, 418,284. *Mechanical Telegraph Instrument*, J. H. Bunnell, 418,443, December 31.

Telephones and Appliances:—*Telephone Exchange Apparatus*, J. J. O'Connell, 417,271. *Multiple Telephone*, A. M. Rosebrugh and T. R. Rosebrugh, 417,511. *Telephonic Instrument*, W. C. Barney, 417,660, December 17. *Ear-Phone Rest*, G. E. Christie, 418,682, January 7.

EXPIRING PATENTS.

Patents relating to Electricity which become Public Property in February, 1890.

Reported for the ELECTRICAL ENGINEER, by F. B. Brock, *Patent Attorney*, 639 *F street, Washington, D. C.*

Circuit for Chemical Telegraphs, T. A. Edison, 135,531, February 4, 1873. *Telegraph Repeater*, L. T. Lindsey, 136,251. *Duplex Telegraph Instrument*, J. B. Stearns, 136,274. *Electro-Magnetic Motor for Telegraphs*, L. T. Lindsey, 136,250.

[Drawings and specifications of any patent will be furnished by Mr. Brock at cost, 15 cents each.]

THE
ELECTRICAL ENGINEER.

Conducted by F. L. POPE AND G. M. PHELPS.

PUBLISHED MONTHLY AT

150 Broadway, New York City.

TERMS OF SUBSCRIPTION.

United States and Canada, - - - - -	per annum,	$3.00
Four or more Copies, in Clubs (each) - -	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies, - -		.30

Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.]

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, MARCH, 1890. No. 99

BACKSHEESH! BACKSHEESH!

JAMES MURPHY is a rumseller whose saloon confers distinction upon the corner of Third and Monmouth streets, Jersey City, N. J. James is perhaps better known among the dwellers in that unsavory vicinage as "Cork," possibly by way of delicate compliment to the city of his nativity. Last fall, to the profound amazement of all decent people, "Cork" Murphy received the party nomination for Assemblyman in his "deestrict" and was subsequently elected to a seat in the Legislature of New Jersey. How this undesirable result was brought about may possibly be conjectured in the light of recent disclosures concerning fraudulent counting and ballot-box stuffing in certain precincts of Jersey City.

Mr. Murphy's intimate and prolonged acquaintance with the commodity known as "Jersey lightning" has apparently qualified him, in his own estimation, to arrogate to himself the regulation of the electrical industries of the state. Accordingly, we find him promptly on hand with a bill for fixing the rates for electric lighting. It is too long to quote, but two or three of its provisions will serve to show its character. The maximum rate for a 16-candle incandescent lamp is fixed at half a cent per hour, and a 10-candle lamp at one-sixth of a cent per hour, while by way of a clincher the bill further provides that if any company shall "ask or demand" any rate in excess of those fixed by the bill, all its franchises and privileges shall thereupon be forfeited, it shall be subjected to a penalty of $500, and all its fixtures "shall become obstructions and nuisances" and be subject to summary abatement by the authorities.

Imagine the glow of virtuous indignation that would overspread the ordinarily stolid and expressionless countenance of Mr. "Cork" Murphy, in case some electric light man should introduce a bill compelling him and his confreres to reduce the retail price of lager-beer from five to two cents per glass, on pain of being officially declared "obstructions and nuisances." But even at this absurdly low figure these philanthropists would receive $10 for each keg of beer disposed of, which costs less than $8, a profit of at least 25 per cent., which is, we fear, far better than the electric companies are doing. But when Mr. Rumseller Murphy charges the poor workingman, as he does, $25 at retail for such a keg of beer—a profit of over 200 per cent.,—he undeniably constitutes himself a most oppressive "obstruction;" all the more unendurable too when we consider that the victim of electric light extortion may take refuge in kerosene or gas; but what, we ask, is the poor laboring man to do, who though consumed by thirst, cannot afford to buy Murphy's beer?

Mr. Murphy's unfriendliness to the electrical industries —no less than to the Queen's English—is further shown by another bill, introduced by him at the same time, the preamble of which sets forth that:—

> *Whereas*, Life and property is in constant danger by reason of the multitude of wires now suspended from poles *and other contrivances* in the public streets in the cities of this state; and, whereas, wires *charged with electricity* are suspended in many places from the same poles on which *ordinary* wires used for telegraph purposes are strung, and by reason of such proximity do render the said wires dangerous when charged with electric current by contact with electric wires; therefore be it enacted, etc.

This bill requires that wires of every description shall be insulated, no exception being made in the case of fence-wires, stove-pipe wires, or even political wires, which latter most alarming oversight we hope Mr. Murphy will remedy at once, and thank us for calling his attention to it.

Still another of Mr. Murphy's bills orders all the telegraph and telephone wires in cities to go underground within one year.

Mr. Murphy's solicitude for the safety and welfare of the public is really touching, in view of the fact that the liquid damnation dealt out from Mr. Murphy's saloon has in all human probabilities slain more victims, made more widows and orphans, inflicted more bodily injuries, and been the direct cause of more casualties of every kind, ten times over, than all the electric plants in the state of New Jersey put together.

We shall try to keep an eye on the members who support Mr. Murphy's bills.

THE KANSAS CITY MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

WE devote the greater portion of our present number to a somewhat condensed report of the proceedings of the Annual Meeting (eleventh semi-annual) of the National Electric Light Association, held at Kansas City, February 11, 12, 13 and 14, with the greater part of the papers read and presented.

The Association still includes in its membership but a fraction of the number of owners or managers of central station electric plants in the country, but it is doing good work for the whole of them in settling down to the careful consideration and discussion of technical and administrative features of the business of electrical distribution that are vital to its prosperity, and in giving something like adequate attention to legislative questions, touching the regulation of that industry, that are cropping out in state and municipal legislatures in various directions.

It was a long journey to Kansas City from the seaboard states, where most of the members of the association are to be found—and attendance at the meeting involved the expenditure of a week's time; but it seems to be the general opinion among all who left their accustomed vocations for the convention, that the week was well spent in the work of the association; to say nothing of the many pleasures enjoyed on the way and at Kansas City through the generous hospitality of western hosts.

The report of the secretary and treasurer showed an increase of membership since July 31, 1889, and a very gratifying improvement in the financial affairs of the association. Whatever apprehension had been felt of defection on the part of associate members, after the convention of August last, are now, happily, dissipated by the figures of the secretary's report, and by the very large attendance of members of that class at Kansas City.

As in so many political gatherings nowadays, harmony was the desire of the officers and executive committee. Fortunately this was attained throughout the convention, and that without suppression of the utmost freedom in discussion or in the expression of opinion. The only menace to the general good understanding that characterized the meeting arose from the very extraordinary and ill-advised attempt of Mr. F. A. Wyman to cut off a member's right to introduce a resolution without first submitting it to the executive committee. The president and members present put Mr. Wyman out of sight as soon as they perceived the significance and absurdity of his "point of order," which thus, happily, fell short of becoming a point of *dis*order.

Among the reports of committees, nearly all of which gave evidence of more work than can generally be got out of committees during the period between semi-annual meetings, that of the Committee on Standardization of Potentials on Street Railways furnished much useful information and valuable suggestion. Through systematic enquiries addressed to all electric railway companies and to the companies manufacturing electric railway outfit, the committee had ascertained, and reported, that the potential employed varied from 220 to 800 volts. The committee found that but nine lighting companies had undertaken to supply railway companies with current. They also reported that on railways operating not less than 15 cars, only one-third of the total horse-power provided for at the central station has ever been required; that on roads running 5 to 15 cars the greatest load has not exceeded 50 per cent. of the total power, and that upon smaller roads the load varied from 50 to 80 per cent. of the station power. These figures are not less interesting to lighting companies having opportunity to supply current for power than to street railway companies. The committee very judiciously advised lighting companies against attempting to furnish power current from their existing lighting machinery, advocating rather the installation of special power plant where opportunity for power service exists. Their recommendation in this regard was enforced by considerations fully set forth in the report, which is printed in full in other columns.

The insurance committee's report led to a long discussion and developed very freely the prevalent opinions in the association on that topic.

The facts of the insurance problem are about as follows: Although, as our readers are aware, some competent underwriters, particularly in New England, take electric risks at reduced rates, regarding electricity as the safest of illuminants, yet many electric lighting companies throughout the country are unable to place their risks except at uncommonly high rates, often prohibitive. It must be that the New England underwriters are wrong (disproved by the fewness of their electrical losses), or that the uninsurable risks are really too hazardous; or that insurance companies generally are unable, through their inspection service, to determine whether they are or are not desirable risks. The truth lies in both the latter propositions; that is, both are partially true. The soundly built, equipped and managed stations are good risks; the flimsy, ill equipped and slovenly managed stations, of which there are still too many, offer no just ground of complaint against underwriters. What to do? The insurance committee recommended that electric lighting companies appoint an instructor to teach insurance inspectors how to distinguish between good and bad electrical risks. This proposition, the committee confessed, had met with a frigid reception at the hands of underwriters' boards to whom it had been communicated. A more important recommendation of the report was that advising the formation of a mutual insurance association, for the insurance of central stations. The merits of such a plan are very obvious. Such an association, consisting mainly or largely of central station owners would be able at once to exercise the most competent and thorough expert inspection of risks, and might easily and soon accomplish more than any other agency could do toward reforming defective construction, equipment and management of central stations wherever needed. It is to be hoped that the adoption of the committee's report will be speedily followed by the organization of an insurance association similar to that proposed, and of which a prospectus was filed with the report. Mr. Marsden J. Perry, unanimously chosen president of the association at the election on Friday, warmly supported the mutual insurance project, and, from his known energetic action in backing his opinions, he may be expected to give that measure prompt and effective attention.

A very gratifying incident of the insurance discussion is to be noted in the good set terms in which Captain Brophy—than whom no one in Boston or elsewhere is more competent to speak touching electricity and fire risks—characterized the finding of the Fire Marshal of Boston, which attributed the Thanksgiving Day fire in that city to electric wires. Said Captain Brophy: "Any one who knows anything about the condition of affairs there, must know that that was not the cause of the fire. I certainly do; and if I had any respect for the electrical knowledge of the worthy Fire Marshal previous to his report, I have since lost it."

Among the many important topics dealt with by the convention was that of "paralleling;"—the establishment of competing plants alongside of those already established, too often encouraged or even incited by rival manufacturing companies, and invariably leading to ruinous competition and the discredit of the business of electric lighting as an investment. A strong committee On Relations Between Parent and Sub-Companies, with Mr. Perry at the head, was appointed to take the matter in hand.

The work of the Committee on Legislation in promoting the organization of State Electric Light Associations had resulted in the formation of ten such bodies. How effectual such state organizations may be made in protecting the business of its members from hostile legislation may be inferred from the success, a few weeks ago, of six or eight lighting companies in various towns of Virginia, who, without organization, sent representatives to Richmond and defeated the pending bill to restrict voltages.

THE common observation that the recital of one fact carries more weight than a dozen theories, has received a curious confirmation in the results which have followed the publication of Mr. Edison's widely circulated article in the *North American Review* on the dangers of electric lighting. The article was a plea against the admission into use, under any conditions, of high tension and alternating electric currents; a proposition which was supported, by a really formidable array of more or less pertinent theoretical objections. But in citing one fact, viz: the fusion of a cubic yard or so of iron, copper, and even street paving-stones into a solid mass, by the electric heat arising from an accidental cross in the conductors of a low tension central station plant, Mr. Edison unwittingly indicated the one radically weak point—from a technical point of view—of the low tension, direct-current system of distribution, the merits of which he sought to advocate, and that is the interconnection of all the mains, by which means the aggregate generating power of the central station may be instantly concentrated upon a defective point wherever situated with the possibility of the most disastrous results.

The views set forth by Mr. Edison, and especially the accident recorded by him—which we think had hitherto escaped publication—has led to a somewhat exhaustive discussion, in the public journals and elsewhere, of the whole subject of safe electrical distribution, the general drift of which would appear to justify the prediction that the alternating system, which, by its complete electrical separation between the house and street wiring, furnishes protection to the consumer from fire as well as from shock, will hold its own for long-distance distribution, however large a field may remain to low tension direct distribution over relatively restricted areas. No system can claim absolute immunity from danger. Energy enough to burn or kill must be employed in any method of electrical distribution for light or power, just as it must be employed in every steam engine; but it can be confined to its proper work, and the danger can be reduced to almost nothing by sound knowledge and practice in both cases.

THE future of the subway question in New York, now depends largely upon the result of the injunction suit brought by the Manhattan Electric Light Co. and Geo. E. Armstrong against the Mayor, the Board of Electrical Control and the Consolidated Telegraph and Electrical Subway Co., to restrain the Mayor and the Board from authorizing the Consolidated company to transfer to the new Standard Electrical Subway Co., or any other, any or all of its subways and the right and obligation to build subways for electric light and power conductors, and to enjoin the Consolidated company from making such a transfer of its rights and duties. Both motions were heard together.

Argument was begun before Judge Andrews in Supreme Court Chambers March 6, and was continued next day. Besides the attorneys of the Manhattan company, other counsel, representing several other electric light companies interested in presenting the proposed transfer appeared, and it is evident that the struggle to forestall the ownership of a general electric light and power subway system by the Standard company will be a determined one. The Westinghouse companies controlling the Standard Electrical Subway Co. evidently have comprehensive plans on foot for electrical distribution in this city.

Meantime the Edison companies, constructing and owning their underground systems, have the good fortune to be out of the fight, which apparently does not touch or menace their operations. They may, therefore, be presumed to behold with serenity the conflicts between other and rival interests.

THE recent destruction of the magnificent building of the University at Toronto, one of the very finest specimens of architecture on this side of the Atlantic, is a loss which the cause of science as well as of Canadian education can but ill afford. It seems that the fire was caused by the breakage of a tray of kerosene lamps, but we are entirely at a loss to understand why it has not been attributed to electricity. The successful demonstration of such a proposition should present but little difficulty to the experts of the daily press, who only the other day, informed an open-mouthed public that an incipient fire in one of our large hotels, which was extinguished with some difficulty, was due to the wires of an electric call-bell which had been installed a day or two before, and which were attached to that most incendiary of all sources of electricity—a cell of Leclanché battery.

SELDOM, if ever, has the Electric Club of New York been better entertained and instructed than it was Thursday evening, February 20th, in listening to the address of Mr. Grosvenor P. Lowrey on "Patent Law, and What Constitutes an Invention." In his inimitable manner Mr. Lowrey traced the history of patent systems from their source, and descanted with his peculiar humor upon perplexing features of the administration of the United States patent laws, illustrating from noted cases. As to what constitutes an invention, he felt compelled to say, as doubtless would also every other thoroughly experienced patent lawyer, that he did not know.

THE following item reaches us too late for insertion in our news columns:—

> P. F. Kobbe, of New York, formerly treasurer of the United States Electric Lighting Co., has been elected to fill the same position with the Westinghouse company, vice Caldwell, resigned. The vacancy in the assistant treasuryship of the same company caused by the resignation of A. T. Rowand, has been filled by the election of W. L. McCullagh. Mr. Rowand remains, as before, secretary of the company.

MUCH to our regret, we are compelled to defer till April, the publication of the third and concluding portion of Mr. Wm. L. Puffer's important article on "Data and Plots of Various Incandescent Lamps, With an Improved Method of Testing."

ARTICLES.

THE PRACTICAL WORKING OF THE ELECTRICAL SUBWAYS OF NEW YORK CITY.[1]

BY WILLIAM MAVER, JR.

KNOWING very well the wide-spread interest that has attended the placing of wires underground in New York city, I have been glad of the opportunity to gather and prepare for presentation to you this evening, such data and information relating to that subject as I have thought would be, and as I hope may be, found of the most value.

I observe that our worthy secretary has announced me in the notice of the meeting as the electrician of the Consolidated Telegraph and Electrical Subway Co., and quite correctly so. I desire to say, however, perhaps unnecessarily, that I have prepared this paper in my unofficial capacity, and am, of course, alone responsible for what may be contained therein.

The customary reply to an inquiry as to what is the best arrangement for an electrical subway is, "Build a tunnel under the streets and place the wires on the walls within easy access of workmen, and into such a tunnel put also the gas and water mains, etc."

Assuming that this would be a satisfactory solution of the underground question, if it could be arranged, let us consider what the cost of such an arrangement would be.

It has been estimated that a subway suitable to contain all the electric wires, gas and water mains of New York city would cost $430,000 per mile. This for Broadway alone from Bowling Green to Central Park would mean an outlay of about $2,150,000, and if such a tunnel were to be built throughout the entire route of the now existing electrical subways of New York city, the bill would foot up to nearly $30,000,000.

This amount it will, I think, be generally admitted, is virtually prohibitory of any such subway at present, and if that is the case, the fact will perhaps make those who have had preconceived ideas in favor of a universal tunnel scheme more tolerant of the electrical subways we have, the practical working of which I am to endeavor to describe this evening.

When the first whisperings of a desire on the part of the public or press to have electric wires in the large cities go underground, were heard in this country, it will be remembered the telephone people with one accord admitted that it would be quite feasible for the telegraph and electric light people to operate their wires underground, but claimed that for them to attempt to operate their circuits thus, meant irretrievable ruin. Equally convinced also were the telegraph people that while it would be very easy for the electric light companies to work their circuits underground, it was quite out of the question that telegraph wires could be operated successfully in subways, since the increased electrostatic and electro-magnetic effects would completely destroy quadruplex and fast automatic telegraphy. And no less emphatic was the opinion of the high tension electric light people that the telegraph, the telephone and the low tension electric light systems could, if required, all go underground without detriment, but it was utterly impossible for them to do so, and at the same time to operate their circuits successfully.

New York city was no exception when the time came to place the wires underground. Gradually, however, the telephone yielded—more gradually the telegraph, but more tenaciously the majority of the high tension people clung to their statements, and the experiences of the cities of Chicago, Philadelphia—especially Philadelphia—and elsewhere were cited as evidence of the futility of any attempt to operate high tension currents underground. These experiences were held to show that no insulation could be procured which would withstand the pressure of the high electromotive force employed on high tension circuits. In addition to this it was also asserted that the requirements of the Subway company regarding the insulation resistance of the underground conductors was high beyond all precedent and unobtainable in practice, and that even if such insulation could be obtained it would be impracticable to make tests of the conductors showing them to possess the insulation resistance required by the rules.

It is very far from my intention to go into a history of the opposition offered by the different electrical companies to placing their wires underground, and in so far as I have just alluded to it I have done so for the purpose of quoting in a general way some of the reasons given by the companies for this opposition, and this only that we may see how far the surmises of those who were thus averse to placing wires underground have been verified by actual results.

It is told of a certain noted geologist that when a specimen of gold quartz, which had been found in a locality where he had stated no gold would ever be found, was shown him, he remarked that if it really had been found there, nevertheless it had no right to be there.

I can imagine that there are many persons—perhaps not in this room—but somewhere, who, if told that telephone, telegraph, high and low tension electric light circuits, and even "deadly" alternating circuits, are to-night in this city working successfully underground in the same streets and on the same side of the streets would reply, "If they really are working successfully there they have no right to be."

In preparing this paper I have found that the subject has almost naturally arranged itself under the following general headings, namely:—

1 The type of conduits used in the subways.
2 The drawing in of cables.
The methods of distribution.
3 The cables employed in the subways.
4 Present condition and probable duration of cables.
6 Joints.
7 Lead covered cables.
8 Insulation and tests.
9 Alleged dangers of the subways.
10 Gas in the subways.
11 General remarks.

I have been unable to obtain with any degree of accuracy the extent of electrical subways or the amount of wire placed in them in the cities of Europe, and, therefore, I cannot say definitely how New York to-day compares with such cities as London, Paris and Berlin, in that respect. But I incline to the belief that it may be found that New York will fall but little, if at all, behind those cities. In New York city to-day there are 73 miles of electrical subways and 1,017 miles of ducts. In these ducts there are 10,906 miles of telephone wire, 945 miles of telegraph wire (including fire alarm telegraph wires), and 457 miles of electric light wires. These subways have a capacity for about 45,000 miles of telephone and telegraph wires and 2,000 miles of electric light wires.

CONDUITS.

There are in the New York electrical subways eight different conduit systems, namely: the Dorsett, the Wyckoff, zinc tubing in hydraulic cement, sheet iron cement lined pipe, wrought iron pipe in hydraulic cement, wrought iron pipe in asphaltic concrete, the Edison iron tube and the Johnstone sectional cast iron conduits. All of these conduits have been frequently described; I shall, therefore, just briefly refer to each.

The Dorsett system consists of blocks formed of a material the ingredients of which are pitch, coal tar and fine gravel. The blocks are moulded, with tubular openings about 2½ inches in diameter, from end to end. The blocks are about four feet long and one foot cross-section. The blocks are placed end to end in the trench, and are joined together by pouring between the ends a liquid compound of pitch and tar which speedily hardens. This compound is prevented from entering the ducts by sleeves which are placed in each duct between the junction of every two blocks. There is about one mile of this conduit, containing 16 miles of ducts, on Sixth avenue. It is used for telephone and telegraph conductors. This conduit was laid three years ago. So far as I can learn it is in a fair state of preservation to-day, but not perfect, the blocks having, in some instances sunk and thus put the ducts out of alignment. It may be noted here that ½ inch tarred hemp, guide ropes of which were laid in these ducts when this system was constructed, to be in readiness when cables were to be drawn in, show plainly in numerous places, signs of deterioration, said to be the result of dryrot combined with the gases found in the ducts.

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[1] A paper read before the Forty-third Meeting of the American Institute of Electrical Engineers, New York, Feb. 18, 1890.

The zinc tube conduits are laid in Fifty-eighth street. The zinc tubing was intended to serve simply as a mould around which hydraulic cement concrete was to be placed, with the expectation that when the zinc had corroded, the tube formed by the solid cement would remain intact. About one mile of this conduit has been in successful operation for three years, but the difficulty attending *the construction* of a conduit formed in this way was so great, owing to the frailty of the zinc tube, which readily gave way under moderate pressure, that its use has not been further extended.

The sheet iron cement lined pipe conduits are made in single or multiple tubes of two, four, six or more ducts, as may be required and in lengths of eight feet. The tubes are connected together by a ball and socket joint. These conduits are made as follows: a sheet iron tube eight feet in length is held vertically; inside of the tube is placed a smaller brass tube; semi-liquid cement is poured into the annular space between the brass and sheet iron tubes. When the cement has solidified the brass tube is withdrawn. The cement tube is then ready for the subways. There are about 113 miles of ducts of this conduit in the subways, and during the coming summer it is expected many times this amount will be laid in New York city.

There are about 15 miles of creosoted wood ducts in the subways, known as the Wyckoff conduits. These ducts are formed of wood piping similar to ordinary pump logs. There are lead covered telephone cables in these ducts, and the action of the creosote upon the lead covering is being carefully watched. These ducts have been in operation for three years. I am informed that detrimental effects are noticeable in the lead covering of the cables, which is alloyed with three per cent. of tin.

The bulk of the subway conduits consists of wrought iron pipe laid in hydraulic cement concrete. These pipes are 20 feet in length and vary in diameter from two to three inches. The thickness of the iron is .217 inches.

In laying all of these pipe conduits the bottom of the trench is first leveled to grade; planks are then set against the side of the trench to sustain it. A layer of concrete is then laid and rammed in the bottom of the trench. On this is placed a row of iron pipe, next a layer of concrete, then another row of pipe, and so on, until the desired number of layers is attained. The number of pipes in a row depends upon the topography of the street and the location of existing gas and water pipes, which it is desired to avoid; and the number of rows upon the total number of pipes desired to be laid in a given subway. In order to add strength to the mass and to protect the ducts from mechanical injury, the concrete is applied more thickly on the bottom, top and sides of the subway than between the pipes. There is placed over all a two inch yellow pine planking, heavily creosoted, to further protect the conduits against injury, from picks, crowbars, etc., in the event of future excavations in the streets.

The wrought iron pipes are joined end to end by a coupling screw joint with a tapering or vanishing thread. By the use of this form of thread, I am informed, the rate of laying this piping is increased 50 per cent. These tubes are delivered free from burrs, and have a smooth inner surface. The pipes are sometimes asphalted to prevent rusting, but should they in course of time rust, it is expected, as in the case of the zinc tube, that the concrete will preserve the shape of the duct intact. There are close upon 550 miles of wrought iron piping in the subways.

The facility with which a pipe conduit conforms to the varying condition of the crowded streets of large cities, as found in the process of trenching, is one of its chief advantages.

The main reasons which have led to the extensive use of wrought iron piping in the subways are its great strength, its adaptability to varying conditions of the street and the rapidity with which it can be laid.

The Edison system consists of wrought-iron pipe in which are placed the copper conductors or rods. These conductors are wound with rope and the pipe is filled with an insulating compound of trinidad asphaltum, rosin, paraffine and linseed oil. These iron pipes are laid directly in the earth. There are about 50 miles of this pipe now laid in New York city.

The subways are in many cases on both sides of a street, and as a rule the telegraph and telephone wires are assigned to ducts on one side of the street and the electric light wires to ducts on the opposite side; but in numerous instances the electric light wires are operated in distributing ducts on the same side of the street as the telegraph and telephone wires, and without detriment to the latter.

MAN-HOLES.

Access is had to the conduits of the New York subways by means of man-holes, placed at an average distance of about one-twenty-fifth of a mile apart. The man-holes are, with a few exceptions, built of brick laid up in concrete cement, with hydraulic concrete bottom. The outside of the walls is coated with cement to prevent moisture and gas from penetrating.

Access to the man-holes from the street is had through the cast-iron head which is set on the brick work, and which is provided with double covers. The upper or street cover weighs about 350 pounds; the lower cover is provided with a rubber gasket to prevent ingress of street water into the man-hole. This cover is funnel-shaped in order that any water which may enter through the upper cover may be drained away from the gasket. The lower cover is screwed down upon the gasket by a gun metal bolt and cross-bar. The upper cover is loose upon its bearings. The ducts enter the man-holes at a point easily accessible to the workmen while standing on the bottom of the man-hole. The average width of the man-holes is about five feet, and varies from 5 to 10 feet in depth. The hand blower used for driving out gas from the man-holes is shown, also the iron frame work or cage which is placed around the opening to the man-holes when the cover is removed.

The foregoing mentioned conduits may be considered as belonging to the regular subway system of New York city.

There are, however, several other conduits in operation in this city, namely, the Brooks, the Western Union and about five miles of telephone cable laid in wooden boxes filled with sand. The Brooks' system has been so repeatedly described I need not further allude to it. The Western Union subway consists of an iron pipe about six inches in diameter, into which wires have been drawn.

RODDING.

The electrical subways of New York city, with the exception of the Edison system, are of the class known as the drawing in and out systems. The first process in drawing a cable through a duct which is not easily accessible except at its ends in the man-holes, is obviously to provide a means of drawing in the cable. This is done by a process technically termed rodding, which consists of pushing rods through the duct from one man-hole to the next. A rope is then attached to the end of the rod and the rod is withdrawn bringing the rope with it. This rope is then employed to haul in the cable. As some of the man-holes are over 500 feet apart, and it would not be convenient to procure a continuous wooden rod of that length—rods of about four feet in length furnished at one end with a screw and at the other end with a screw socket are used. These are placed in a bunch in the man-hole and are attached by the screws, one to the other, as many as are required to reach to the distant end of the duct. The rods are then detached as they are drawn out by unscrewing the ends. This is a specimen of this form of rod (showing). It is the one most generally used. There are other forms of rod also in use in the subways. This (showing) is one of them. It is furnished with a slot into which the T-end fits, but into or out of which it can only go at a certain limited angle. Therefore, while this joint or connection is quite loose there is no likelihood of the rods coming apart in the duct, because the diameter of the ducts does not permit a sufficient movement of the rod at the joints. The time taken in rodding a duct of 300 feet in length is about 20 minutes.

Continuous steel wire rods about one-quarter of an inch thick and from 300 to 500 feet long are also used for rodding the ducts. These rods are mounted on a reel about six feet in diameter which is placed adjacent to a manhole and from which it is reeled off as the rod is pushed through the duct. When this operates freely, it is more expeditious than the wooden rod methods just described, as the time taken in jointing up the rods is saved; but it is found that the wire occasionally buckles in the duct and, furthermore, it is more apt to be caught by any obstruction or unevenness, than are the wooden rods, so that by many the latter are employed as being the more expeditious, all things considered.

There is also another method of rodding sometimes employed, which consists of a long spiral steel rod, the spiral of which is about one inch in diameter. On the circumference of the spiral small wheels are mounted to ease the friction. This rod is also placed on a reel and wound off as it is fed into the duct. This spiral while quite elastic is yet capable of withstanding considerable pressure. This rod is pushed into the duct in the usual way. The expense and the weight of this form of "rod" is somewhat against it, although I am informed that by its use a duct can be rodded in one-half the time required by the screw rods.

Before those employed in the work of drawing in conductors into subways had devised and settled down to the forms of rods just described, many bright minds were at work on the question of how to rod the ducts. The scheme of tying a string to a rat's tail and sending him through the duct with a ferret after him was tested practically in Brooklyn, I believe, but the plan was not generally adopted. In the case cited, it is stated that the ferret overtook the rat and stopping to eat him was overcome by the gas and asphyxiated. This necessitated the tearing up of the street to get at the remains.

In Chicago, it was seriously suggested that a wooden ball with a string attached to it, be placed in the duct and that then a hose connected with a neighboring hydrant be inserted in the duct. The water was to force the ball through the duct. This plan was found to work successfully so far as getting the ball through was concerned, but it flooded the man-holes, and was not put into general use, even in Chicago.

Another inventor devised what he called a mechanical creeper, which was designed to advance itself through the ducts by putting out arms against the walls and thus pushing itself along.

Sometimes in rodding, obstructions are met with, caused by pieces of cement, stone, dirt, etc., gaining access to the ducts. Sometimes, also, obstructions are caused by uneven joints in the conduits. Ordinary obstructions are removed by a mandril placed on the first rod.

DRAWING IN CABLES.

After the rope has been attached to the cable, the latter is then "threaded" through the duct. The attaching of the rope to a cable is a matter of some skill. The connection is so made that the strain comes chiefly on the conductors. To prevent the cable or cables from twisting as drawn in, a swivel is inserted in the rope near the cable.

The manner of applying the force necessary to pull the cable through the duct depends upon the size and length of the cable. If it is a small cable, say 300 feet in length, it can be drawn in by two or three men. If it is a large cable, or if four or six small cables are to be drawn into one duct, as is frequently done, more elaborate drawing in apparatus is used. This generally consists of some form of winch. The largest telephone cables are drawn in by a winch of special construction, in which the power is transmitted through the intervention of wheel gearing. As a rule, it may be said that in the matter of drawing cables into the ducts the work has been satisfactorily performed. In a few instances mistakes have been made, as in the attempt to draw too many cables into one duct—the old problem of putting a three inch bung into a two inch hole—and in the attempt several lengths of cable have been jammed in the ducts and injured.

As many as six electric light cables, No. 4 B. & S. conductors have been repeatedly drawn at once into a three inch duct. It is not deemed advisable to draw cables into or out of ducts over cables already laid, but in cases of necessity it has been done without injury to the cables.

As the weight of a No. 4 B. & S. lead covered cable is for 300 feet, say 250 pounds, an idea may be obtained of the force required to draw in six such cables. I am informed that cables weighing in the aggregate 5,510 pounds, have been drawn at one time into one duct.

METHODS OF DISTRIBUTION.

It is, of course, a comparatively easy problem to arrange an electrical subway for trunk line circuits. The difficulty arises when the question of distribution of the current from the main conduits is to be considered, as when, in the case of the telegraph and telephone service, it is desired to furnish city customers with circuits; and in the case of electric light service when it is required to make house to house or street lamp connections.

In the case of telegraph and telephone distribution, subsidiary pipes or ducts are generally led from an adjacent man-hole to the front or side of buildings, whence the cables are continued to the roof of the building or to the back yards, from which latter points the circuits are radiated as required.

The cable of the telephone company is generally made up into 50 pairs. When this number of circuits is not required in one block or series of blocks, the cable is forked in the man-hole, one portion of the conductors being led in a smaller cable in one direction, another portion elsewhere as may be required. This method of distribution has been found convenient and satisfactory.

Distribution of the electric light current is effected in several different ways in the New York subways. For street arc lamps the circuit is usually looped from the manhole to the lamp post through a subsidiary iron pipe.

For easy access to houses and to lamps in the middle of blocks, distributing ducts are laid above the trunk ducts as near the surface of the street as practicable. The average distance from the surface of the street being, perhaps, 18 inches.

The Johnstone sectional conduit, has hitherto been the most extensively employed for this purpose in New York city. This conduit consists of sections of cast-iron ducts about five feet in length. The sections are placed directly above each other and are held together when in position by removable clamp pins. The upper section rests in a groove in the lower section. Each section of the conduit is divided into 2–6 or more compartments or ducts—depending upon the size of the section,—the ducts being formed by removable partitions or slats held in position by suitable channels or grooves within the sections. Opposite each house or every alternate house, a hand-hole is provided in the upper section of the conduit. This hand-hole consists of a removable cover, about two feet in length, on the upper section, and the side of the section at this point is provided with a branch or spigot.

This conduit is laid directly in the earth, not in cement. When it is desired to obtain access to a conductor to tap or loop a circuit into a building, the paving and earth are removed from the street and the cover of the hand-hole is lifted, thus exposing the conductors in the ducts. A 3-inch iron pipe is run from the branch at the hand-hole to the basement or vault of the house or to the lamp post with which connection is desired to be made. This iron pipe fits the spigot at the side of the conduit. The connection is then made with the conductors by splicing on short lengths of cable leading through the iron pipe to the house or lamp. Should the conductor which it is desired to tap be at the side of the section remote from the spigot, the intermediate partitions are removed to permit the passage cross-wise of the connecting cable. After the joints are made, the cover of the hand-hole is replaced and the earth and paving are restored to their normal condition.

When a hand-hole has not been provided originally at a point where access is desired to a conductor in the conduit, the entire upper section is removed and replaced by a half section containing a hand-hole cover and spigot. This work can be done in a short time. The sections in use for this purpose are in some instances somewhat small for ease in joint making especially, as but very little slack is available when T joints are to be made, and, therefor in future, larger hand-holes will be provided. These conduits are presumably made air and water tight at the junction of the two sections, and at the ends of the ducts, by the use of plumber's putty. In view of the number of supposed opportunities for the entrance of moisture at these junctions it would be naturally expected that this type of conduit would be in a chronic moist condition. Indeed it has been predicted of it that the ducts would act as canals for the surface water, but, as a matter of fact, these ducts are almost invariably dry. There are two theories given to explain this fact. The first, that in reality the plumber's putty makes an air and water tight joint. The second, that if the joints are so imperfect as to admit water, they are quite capable of permitting its escape also. It must be said that this conduit has been found of much utility in the practical distribution of electric light current in this city.

More recently a method of distribution in which wrough iron pipes are used has been employed. This consists of a row of three or four iron pipes laid, like the Johnstone conduit, as near the surface as possible, in the earth, without concrete. Opposite every party wall, or, in other words, at distances of about 50 feet apart, iron boxes, about 18 inches square are placed. These boxes have removable covers. The ducts enter at the ends of the box but do not pass through it. The boxes are provided with sides opening also for the entrance of the subsidiary iron pipes. Access is had to these boxes also by the removal of the street paving and earth.

This method of distribution has, like the one just described, been found satisfactory. Certain mechanical improvements in the construction of both are, however, desirable, and are contemplated.

When it is desired to cross a street to reach customers subsidiary ducts are constructed.

It is frequently remarked (presumably derogatory of the existing electrical subways) that no system of house to house distribution can be considered perfect which requires the tearing up of any portion of the street to obtain access to the mains. This will be granted by any one. The same is equally true of the house to house distribution of gas and water from the street mains. In all of these cases if the connections were made from the street mains to every house and vacant lot along their routes when the mains are first laid the necessity for reopening the streets to make house connections would be avoided. But I have yet to learn that this is done by either the gas or water companies, nor have I heard that their neglect to do so has been seriously animadverted upon.

It would, therefore, seem unreasonable that the additional expense of making these connections, which may never be required, should be urged upon the users of the subways by any who have the interests of electrical industries at heart, especially while they ignore the failure of the gas and water companies to make corresponding connections.

THE CABLES AND INSULATION USED IN THE SUBWAYS.

In the telephone service in this city the cables used are chiefly of the type known as the Patterson. This cable is constructed as follows: Ordinary cotton covering is first placed around the wires. After the wires are cabled a lead covering is placed over them and paraffine is then forced into the interstices between the conductors and lead covering.

This cable has an electrostatic capacity of about .16 microfarad. The insulation resistance of the cable, laid and jointed in the subways averages about 100 megohms. The longest stretch of cable used by the telephone company in the subways is seven miles. The greatest number of conductors in any one cable is 100 or 50 pairs.

The telephone service in the underground conduits was impaired somewhat, so long as ground circuits were used, but since the adoption of metallic circuits the service is satisfactory. On the long-distance telephone circuits the seven miles of cable is, of course, somewhat detrimental.

The telegraph companies have thus far used, chiefly for underground service, kerite, okonite, Standard Underground and Patterson cables. The kerite and okonite insulation, it is well known, are homogeneous compounds. These cables are not lead covered. Of course they could be. The Standard and Patterson are fibrous cables and are lead covered.

Except in the vicinity of the underground steam pipes, the unprotected homogeneous cables have given uniform satisfaction. But, as might be expected, the effect of escaping steam upon them has been detrimental.

Fortunately the heated area in the vicinity of the electrical subways is limited to a portion of the down-town districts. Investigation has shown that the heat only reaches a harmful temperature in the neighborhood of actual leaks in the steam pipes. Measurements of the temperature of a man-hole in the worst section of the heated district have shown as high as 150° to 200° F. Since the starting of the blowers in this district to ventilate the subways a noticeable decrease in the temperature is observable, and, inasmuch as the steam heating company is achieving some success in its efforts to close up all leaks in the pipes, it is anticipated that the heat difficulty will be eventually removed from the subways.

The users of the Standard and Patterson cables state that those cables are giving very fair service in the heated portions of the subways, although the high temperature, of course, lowers the insulation resistance of the cables.

The average number of conductors in the telegraph underground cables is about 50. The size of the wire used is, as a rule, No. 16, B. W. G., and the outside diameter of a conductor, including the insulation, is 6-30 seconds. The insulation resistance of the okonite insulation is about 2,500 megohms; that of kerite 500 to 800 megohms, and that of the Standard and Patterson about 1,500 megohms per mile for the thickness of insulation just mentioned.

Outside of the injury to the cables due to the presence of the steam heating pipes, no undue deterioration of the telegraph cables in the subways has been noted.

The effect of the increased electrostatic capacity of the underground circuits has not caused any marked inconvenience in the operation of the telegraph circuits.

The comparatively low mileage of telegraph wire in the subways is partly explained by the fact that the bulk of the telegraph circuits in New York city are suspended from the elevated railroad structures. The Fire Alarm Telegraph cables in the subways do not differ very materially from those used by other telegraph companies. The fire department thus far has used Standard Underground cables.

ELECTRIC LIGHT CABLES IN SUBWAYS.

In the electric light service in the subways—and I am aware that it is around this that the greatest interest centres—there are, exclusive of the Edison system, four different types of insulation used, namely, the Bishop rubber compound, the Standard Underground, the Safety insulated and the Cobb vulcanite-paraffine cable. All of these cables are lead covered as a precaution against mechanical injury, action of acids, etc., or moisture. Specimens of these cables are on the table.

The sizes of conductors used in the electric light service vary with every company and with the character of the service. For feeders the conductors range in size from No. 6 noughts B. & S. to No. 2 B. & S. For mains, from No. 2 to No. 6 B. & S. In many instances No. 10 B. & S. is used for connecting from the mains to lamps through the subsidiary ducts.

THE STANDARD UNDERGROUND CABLE.

The insulation of the Standard Underground cable is obtained by first wrapping thick cotton thread or cord around the wire to any desired thickness. The wire thus covered is then placed in a cauldron of boiling insulating compound—a product of petroleum. This treatment displaces any moisture that may be in the cotton thread. After the cotton has been thoroughly saturated with the compound the whole is then lead covered. Care, is of course, taken by soldering up the ends of the cable to prevent absorption of moisture in shipment and in drawing into the ducts.

There are now in actual service for electric lighting purposes in the New York subways over 95 miles of this cable, carrying currents of an E. M. F. of from 300 to 3,000 volts, including many 1,000 volt alternating currents, and an additional 50 miles of the same cable will shortly be in operation. The thickness of insulation used in these cables is 5-32, 6-32 and 7-32 of an inch. This refers to the thickness of the insulation from any given point of the circumference of the conductor.

THE "SAFETY" CABLE.

The insulating material of the "safety" cable is an India-rubber compound. It differs somewhat, I believe, from the ordinary run of India-rubber compound cables in that the compound is placed over the wire, without seams or laps of any kind. This compound is vulcanized to a moderate degree of hardness sufficient to prevent decentering of the heavy conductors which it insulates, but yet it retains a high degree of flexibility.

The thickness of insulation used in No. 4, B & S. wire, 204 inch diameter, is .108 inch. The weight of this conductor, lead covered, is 4,861 lbs. per mile. Of this the wire weighs 665 lbs., the insulation 669 lbs., the tape 95 lbs., the lead covering 3,432 lbs.

A special thickness of this insulation was made in one instance in response to a call for cable to withstand a strain of 7,000 volts for arc lighting. A sample of this cable is on the table; the thickness of the insulation is .238 inches. The conductor is No. 4 B. & S. gauge. This cable is now in the subways. Its length is about three miles. I am not aware that it has yet been called upon to withstand the prescribed 7,000 volts.

There are now over 65 miles of the "safety" cable in actual use in the subways, assigned to electric light circuits carrying continuous and alternating currents of from 1,000 to 2,500 volts E. M. F., and about 15 miles additional are now being placed in subways.

THE BISHOP RUBBER COMPOUND CABLE.

The Bishop rubber compound cable is of the well-known Silvertown type; having first a coat of rubber without sulphur, then a coat of rubber compound with sulphur and over this a lapping of rubber cable which is then taped. There are two sizes of this cable in the subways, namely, No. 4 B. & S. and No. 6 B. & S. The thickness of the insulation is 4-32 inch; the thickness of the lead covering is 5-64 of an inch; the outside diameter of the cable is .65 of an inch; and the weight of the cable is about 3,432 lbs. per mile. There are of this cable in successful operation about ten miles assigned to alternating currents of 1,000 volts, and five miles to arc circuits of 2,500 to 3,000 volts E. M. F. Double this amount of this cable will soon be laid for similar purposes.

THE "COBB" CABLE.

The Cobb vulcanite-paraffine cable is of a somewhat unique construction and design. It also differs, materially in one respect, from the other cables described, in that the conductor is freely movable within its insulating medium. The cable is made in practically the following manner: A vulcanite tube is first made in lengths of about 300 feet. This tube is moderately flexible. The tubing is vulcanized in boiling paraffine. The wire is then threaded through the tube after which the sections of tubing are jointed together. A thick cord is then wound spirally around the vulcanite tube. The whole is then lead covered, and the space between the vulcanite and lead formed by the spirally wound cord is filled with paraffine.

There are about 25 miles of this cable in the subways.

In the case of the Bishop, Safety, Cobb and Patterson cables, the lead is alloyed with about 3 per cent. of tin. The lead covering of the Standard Underground cable is unalloyed, but it is covered with a thick cotton braiding soaked in "P. & B." paint (the latter a product of petroleum) which it is claimed will protect the lead from acid gases, etc., and the braid also acts to protect the lead from mechanical injury.

CONDITION OF THE CABLES.

I may say that all of these cables are guaranteed by the manufacturers for three years. This term, however, is not to be taken as signifying the limit placed upon the life of the cables by the manufacturers.

It is over a year since current was turned on the first high tension electric light circuit in the New York subways. This was a circuit in 125th street, belonging to the Harlem Electric Light Co. The insulation resistance of the cable, as measured just before the turning on of the current, showed it to be 1,750 megohms per mile. A test made of the same circuit last week, after one year's continuous service, showed it to have an insulation resistance of 1,516 megohms per mile. Since the installation of the circuit just referred to, electric light cables of the various types described, have been drawn into the subways almost as rapidly as they could be manufactured, and tests made of the conductors, months after the initial test, have shown them to be in the same electrical condition as when first laid.

There have been several burn-outs in cables in the subways within the year, but with the exception of an abandoned cable, to which I shall refer later, these burn-outs have been traceable in every case to defective joints or to mechanical injury. In all, according to there cords, and best obtainable information, there have been, exclusive of those in the abandoned cables, but five burn-outs, in over 185 miles of electric light wire during a period of active service of the conductors, ranging from one month to thirteen months.

In the case of 27 out of 34 of the electric light circuits in the subways, not a single defect of any kind has occurred since they were placed in the ducts.

There have been several instances when faults not amounting to burn-outs have been discovered by the regular tests, which have brought the insulation resistance of certain conductors below the requirements of the rules of the subway, but these defects have generally been located and removed without serious delay to the circuits. Where this has not been the case, it can be fairly attributed to the employment of untried insulation, unfamiliarity with underground service, or to the inexperience of the men to whom the work of connecting up circuits, etc., has been intrusted. For example, in a number of cases grounds have been traced to contact of the conductor with the lead covering, and the linemen so connecting them have explained that they were not aware the lead covering would cause a ground.

On several occasions grounds have been caused by the driving of nails through the lead covering of the cables or leading in wires, under the moulding inside of buildings, and again a ground was caused by a laborer's pick-axe while excavating for a new subway which crossed an existing subway. It is related of the laborer that when he saw the smoke arising from the burning insulation he first tried to put out the fire by throwing water over the cable and subsequently by throwing wet mortar around it.

It is perhaps not remarkable, in view of all the circumstances, that anything in the shape of an electric wire is looked upon by outsiders with serious apprehensions. It has sometimes been amusing to notice the wide berth given even the leading in wires used during the making of tests of cables, by the occupants of buildings from which the test is being made.

On one occasion while a test was being made in the basement of the Hotel Brunswick, it happened that the lead wires were lying on the floor near by a small pool of water in a hallway. A servant seeing the water and the wires in close proximity called out in alarm to one of her companions who was approaching, "Take care Mary, the electricity is running out."

DEFECTIVE CABLES.

In the case of the cable previously referred to as having been abandoned, the burn-outs were of almost nightly occurrence. The delays to the company using this cable were necessarily vexatious, and I may say that in my references to burn outs, defects, etc., occurring in underground cables, I have not included those that were due to the use of this seemingly inherently defective cable. This was a lead covered cable with a vulcanite tube as an insulating medium. This special cable has been abandoned, and is no longer in service in the New York subways. What may appear a singular feature in connection with the burn-outs in this cable was the fact that it had a higher apparent insulation resistance than any other cable in the subways, and would frequently on a test show an insulation resistance of over 4,000 megohms per mile, a few hours before the occurrence of a burn-out. The same cable showed even a higher test at the factory, namely, about 20,000 megohms per mile. In the latter case it was tested with 400 volts. Burn-outs on this cable have occurred when the pressure employed on the circuit did not much exceed 600 volts.

The explanation of this may be that owing to the nature of the insulating material and to the fact that it was not tested under water before being lead covered, there may have existed fractures in the tubing, or such fractures may have been caused in process of drawing the cable into the ducts. Under the tests made with the 100 and 400 volts E. M. F. of the testing battery the fault would not develop; under the high electromotive force of the dynamo and the current of 10 or 12 amperes, the fault would develop; perhaps due to moisture of condensation of the air in the tube caused by the heating of the wire. This explanation is apparently confirmed by the fact that 25 miles of a somewhat similar cable, namely, the Cobb cable (which I have described), but in which paraffine is placed between the lead covering and the vulcanite tube, has been in successful operation in the subways for high tension currents for over two months without any indication of a defect having occurred.

It was rather unfortunate that the type of cable which I have said has been abandoned as unsatisfactory and which has indeed been withdrawn from the subways, appears to have been the only cable used for electric lighting purposes in the New York subways, which came to the notice of an English electrical engineer, during a flying visit to this country, and a description of which cable he presented to our sister society in London in a recent paper with a favorable prediction as to its probable success.

LOCATING FAULTS.

The method employed for locating faults in electric light conductors in the subways, is to test the conductor from point to point until the defect is placed between two lamps or man-holes. When a fault is located between two lamps or two man-holes, if it is in the cable proper and not in a joint at a hand-hole or box, the defective section is withdrawn and a perfect section put in its place. With the exception of the hard rubber cable referred to, this has, I believe, been necessary but on three occasions after the current has been turned on the circuit; in two of these the defects were caused by improperly made joints. In the other case by a mechanical injury.

In the case of arc light or series circuits, defects in the cables are more readily located than in multiple arc circuits, because of the facility afforded by the openings at the lamps for testing the conductor in sections. In the case of multiple arc circuits there is at present no means of locating faults but by cutting the conductor in man-holes. For, as the house connections are made from the cable by T joints, it is obvious that the only effect of disconnecting the lamps or converters from the cable is to separate the two conductors of the circuit. These remarks, it is understood, do not apply to the Edison conductors, to which, it is well known, access is had at the ends of each pipe, by removing the paving and earth above the pipe.

No attempt is made to locate faults in electric light circuits in the subways by electrical measurements, for the reason that the obstacles in the way of obtaining accurate data are so numerous that it has not been considered expedient to rely on the results of such measurements. For instance, the uncertainty as to the distribution of the resistance of the conductor, owing to the numerous joints in the circuit; the variations in temperature of the subways and the difficulty in ascertaining it, etc.

To facilitate the locating of faults, should they occur in the subways, several forms of accessible joints have been suggested for use in the man-holes. One of these known, I think, as the Dillon joint, consists of a metal cup having in its bottom apertures through which the cable ends pass. The lead covering of the cable is soldered into the cup, the conductors are connected or spliced and insulated when a water tight cover is screwed over the cup.

Another accessible joint, known as the Cobb joint, is made as follows: A copper disc is soldered on the ends of the conductors to be connected. Over the discs a vulcanite sleeve is placed. Two shoulders having respectively a right and left hand screw are placed, near the sleeve, over the insulation of the conductor. The sleeve is provided with a right and left hand thread. The forward movement of the shoulder is checked by the discs on the ends of the conductors. Thus when the sleeve is screwed on to both shoulders the tendency is to press the two discs together tightly. This joint can be made quickly; but as to its practical utility it is not possible to speak definitely as yet, since it has not been in actual service in the subways, so far as I am aware. The same is true of the Dillon joint.

It is, perhaps, a debatable question whether easily accessible joints are desirable in the man-holes of subways, as the tendency in such cases might be to lead to accidents by the exposure of live wires.

DURABILITY OF CABLES.

Concerning the much discussed question as to the relative durability of rubber compound and fibrous cables, I do not think sufficient time has elapsed in the case of the cables in the New York subways to enable one to arrive at a definite judgment. In the case of both types of cable, as I have already said, many circuits have been running continuously for over nine months, and in some instances for over one year, without a defect of any kind, electrical or mechanical having occurred, and the slighter defects that have occurred on other circuits have as yet been so few in either type of cable as not to certainly show any marked superiority of one type over another. Specimens of cable that have been examined after nine to twelve months service show no physical or electrical signs of deterioration of the insulation.

As regards the question as to which kind of cable will best withstand the heat from steam pipes adjacent to the subways—it would appear thus far that the lead covered fibrous cable is superior to the homogeneous cable *not* lead covered. Lead covered rubber compound cables have not as yet been tried in the heated districts.

MULTIPLE CABLES.

These are no concentric cables in the subways in this city. The mains of multiple arc circuits are operated in separate lead covers in the same duct. It is contemplated, I believe, by some of the companies to use one lead cover for such circuits hereafter. One objection on the part of the companies to the use of concentric cables is the anticipated difficulty in making joints, especially where frequent connections for distribution are required. This objection should not hold good in the case of the feeder portion of the circuits.

As to the use of multiple cables for electric lighting. One such cable—a fibrous cable—having eight conductors under one lead cover was placed in the subways but has not been operated as yet, trouble having been found in making perfect joints. I have no doubt that with the experience since had in joint making, this difficulty would be overcome; but it seems to be the general opinion that the use of multiple cables is not advisable in electric lighting.

On the subject of loss due to increased electrostatic capacity or to increased self-induction of conductors in the subways, I may say that I have made careful inquiry of superintendents of stations where the alternating current is used, and learn that no perceptible difference in the operation of the circuits as compared with similar circuits overhead is noticeable. I have been informed that in wet, stormy weather a decided improvement is observable—in fact that the condition of the weather does not affect the circuits. This will be readily understood when it is stated that a recent test, made during the prevalence of a drenching rain storm, of an arc circuit in the subways four miles in length, showed an insulation resistance of 2,400 megohms per mile. The lamp connections were disconnected from the cable proper during the tests, so that the entire cable was under cover except at the pole.

JOINTS.

When it was being urged upon the electric light companies of this city, that they were not using due diligence in placing their wires underground, the companies retorted that they were doing so as rapidly as it was possible, consistent with good workmanship, and stated that it was not possible to joint up the cables more rapidly than was being done with the number of capable jointers at their command. To this an official of the city replied, that this did not, in his opinion, constitute a valid excuse while so many poor men were idle who would be only too glad to be given work at jointing the cables.

This was the view of a layman, but it would seem that in a number of instances in the electric light service in this country a similar view, namely, that anyone could make joints, and that any kind of joints might be made was held by those who should be supposed to know to the contrary.

In this city, I think, it is now fully recognized, by the electric light companies at least, that it pays to employ good jointers in underground work.

Several forms of joints are used on the electric light cables in subways, among them one known as the rubber joint. It is sometimes termed the half marine joint. This joint is made practically as follows: First the lead covering is removed for about three inches from the end of the conductor. About one inch of the insulation is then removed from the ends of the conductor, the ends of the conductor are then "sweated" together. Generally a split copper sleeve being placed over the ends. When a T joint is to be made, a T sleeve is used. This facilitates the making of the joint by dispensing with filing the ends of the conductor and then wrapping them with small wire. No acid is used in the making of the joint. Resin is commonly used as a slag. After the wire has been spliced, the insulation is then scarfed for about three-quarters of an inch, when a layer of pure rubber strip is wrapped around the wire spirally back and forth about three times, and each time the rubber is brought further up the scarfed insulation. A few layers of white rubber strip is then wound above the pure rubber strip and after that a layer or two of pink rubber strip. A layer of fibrous rubber tape is then put on over all. Between each layer of rubber strip a small quantity of rubber solution is put on to make the rubber adhesive and practically homogeneous. A lead sleeve is then placed over the joint and wiped on to the lead covering. This joint can be made in about 20 minutes, exclusive of time taken in wiping the lead sleeve. This joint is used altogether on the "Bishop" and the "safety" cables. Also, occasionally on the Standard and Cobb cables. But as a rule the Cobb people make a special joint somewhat as follows: The ends of the conductors are spliced in the usual way, a hard rubber ferule having first been placed over one end of the conductor and a brass ferule over the other conductor, above the insulation. A machine like a double vise is then placed over the lead covering of the cable and made fast thereto. A tightening device next draws the ends of the vulcanite together, taking up slack in the cable. The vulcanite sleeve or ferule is then welded by heat to the vulcanite tube, after which the brass ferule is drawn over the tube. A mould is then placed around the joint into which molten lead is poured, thus casting a solid lead sleeve. This is quickly cooled by the application to the mould of cold water. The mould is then removed and the joint is complete. This form of joint has been found satisfactory, I believe, and it is claimed that it can be made in much less time than a half marine joint.

The joint chiefly used on the Standard Underground cable is made differently from either of the foregoing. After the conductor has been spliced as usual and the lead covering has been cut back from the insulation, a few turns of tape is passed around the splice. A leaden sleeve is then put on over this and wiped firmly to the lead cover of the cable. When this has been done a couple of small holes are punctured in the lead sleeve through which a boiling insulating compound, used in the manufacture of the cable, is poured, filling up the sleeve completely, after which the holes are closed by solder. These joints have been found to give excellent service on this form of cable. The time taken in making this joint is about 30 minutes.

LEAD COVERED CABLE.

The cables used in the electric light service in the New York subways are, as I have elsewhere stated, without exception lead covered. In the case of fibrous insulation, this is essential to exclude moisture, but not in the case of the rubber cables except as a protection against gas and acids, and, to a certain extent, mechanical injury. The use of this lead covering is not required by the subway rules. In addition to being a protection against the attack of acids and gases, the lead covering is considered a safeguard against accidents to men working in the man-holes amongst live wires. For, if a defect should occur in the insulation in the man-hole, the presence of a ground furnished by the lead covering would make the defect known at the regular test, which, if the defect were of a serious nature, would ensure its being located and eliminated. Whereas, if the conductor were not lead covered there is a probability that a defect in the insulation might occur that would not be indicated by the test, but which might expose the conductor and render it impossible for workmen in the man-holes to make contact therewith. It would be quite possible for a workman to handle the lead covering of even a defective conductor without injury since the lead covering is grounded throughout the length of the subway.

It will hardly be credited by some people, but it is a fact, that live electric light wires conveying the alternating high tension arc currents are handled and moved about in the man-holes by means of the lead covering without the slightest indication that such wires are alive. In fact, it is quite a common occurrence to start up alternating circuits immediately after a rubber joint has been made in order to save time, and then to have the plumber adjust and wipe the sleeve on to the lead cover while the current is in full operation.

Another fact is this, that in the subways, no shocks whatever due to induced currents in the lead covering are felt by the workmen in handling the lead covered cables conveying the alternating current. It is quite conceivable that such shocks might be noticed, as I believe they are, where the cables are suspended from point to point and insulated. In that case, any one handling the lead covering of the conductors would doubtless receive the accumulated induced charge.

It has been stated frequently that such induced currents, where the lead covering of the conductors is insulated, have been known to injure the lead covering and eventually to destroy the insulation.

So far as I have been able to ascertain, not in a single instance has such an action taken place in the subways.

As a matter of fact, close personal observation and careful inquiry on all sides have failed to discover thus far any sign of deterioration in the condition of the material of the conduits; the lead covering of the insulation or of the insulation of the cables in the subways, with the exception of the effect upon the lead covering of the telephone cable in the creosoted wood conduit, referred to. I may add that even in the latter case, personal inspection and inquiry made of workmen, have not confirmed the statement that the lead covering had been attacked. At all events there is no evidence of any such wholesale manufacture of white lead as has been reported from other places where lead covered cables have been placed in creosoted wood boxes.

INSULATION AND TESTS.

The requirements of the rules of the Subway company as regards insulation are such that none but a first-class insulation can well be employed on the conductors conveying currents of high electromotive force. These rules require an initial insulation resistance of 15 megohms per mile per 100 volts electromotive force employed on the circuit, and a minimum of 5 megohms per mile per 100 volts. The initial test is made when the conductor is first laid in the subway and prior to the turning on of the current. The minimum requirement is allowed after the circuit has been in use. This insulation requirement refers to the conductor proper in the subway, and does not include the lamps, aerial connections or converters. The rule does not apply to conductors conveying currents of less than 100 volts E. M. F. In the case of alternating circuits, the uniform electromotive force employed in this city being 1000 volts, the conductors to be employed in this service are required to show an initial insulation resistance of 150 megohms per mile, and a minimum insulation resistance afterwards of at least 50 megohms per mile.

The average E. M. F. of the arc light circuits in the subways is about 2,000 volts; but in some instances it runs up to 3,500 volts. In the latter case, the initial insulation resistance required by the rules is 525 megohms per mile. Minimum, 175 megohms per mile.

It was first thought by many, that it would be impossible to maintain even the minimum insulation resistance required by the rules, and this supposed impossibility was cited by some of the electric light companies as an instance of the impracticability of the proposition that they should utilize the subways. The representative of one such company very naively stated that it would certainly be impossible for his company to maintain this insulation if compelled to go into the subways, as the insulation the company used in its service was "underwriters'." One of the experts of the same company, in his evidence, repeated the very common remark that one megohm, *if it could be maintained*, would be quite sufficient for practical purposes. I do not think that this statement will be seriously contradicted; but the difficulty is to maintain the insulation at one megohm in practice. Experience in the New York subways has shown that it is vastly easier to maintain the insulation resistance at 150 and even 500 megohms per mile than it has been in the past in other cities to maintain them at one megohm per mile. A gentleman writing of the Chicago underground system, not quite two years ago, remarked: "It was found that although the insulation measurement of the lead covered cables in the conduit was very high, considerably above a megohm, a short circuit would form generally within 1,000 feet of the station between the two sides of the circuit."

The explanation for this short circuiting under such conditions would appear to be simple, namely, that if the insulation resistance of a conductor is but one megohm per mile, the covering being of the ordinary thickness, it is clear enough that it is decidedly inferior insulation, and if the normal insulation resistance of the conductor is very much higher than one megohm per mile, but the measurement nevertheless shows it to have an insulation resistance of but one megohm, it is or should be sufficient evidence that a fault has developed in the insulation which need surprise no one when it produces a short circuit or burn out.

As I was in no wise responsible for the promulgation of the subway rule which places the initial and minimum insulation resistance of the electric light conductors at the figures given, not having been connected with the company in any capacity at the time the rule was authorized, modesty need not restrain me from saying, that experience of over a year has amply proven the wisdom of those requirements. For these requirements not only necessitated the use of an insulating material possessing high specific insulation, but also compelled the exercise of the greatest care in the details of placing the conductors in the conduits, in the making of joints, etc.

When it is stated that these conductors are jointed at every man-hole, and in many instances at several places between man-holes, the need of such carefulness in order to maintain a high insulation will be understood.

If, for example, the method of making joints, that it is related was employed some years ago in Philadelphia, namely, to strip the ends of the lead covering for two or three inches, and then to place three or four turns of tape around the ends of the conductor, had been followed in the New York subways, and had been permitted in the absence of the rules referred to, I make no doubt I would have had to report to-night a continued series of failures in the electric light service similar to those so often quoted as having happened in Philadelphia. I am confirmed in this belief by the fact that the first electric light conductors laid in the New York subways were found to possess an insulation resistance of but little over 100,000 ohms. This, notwithstanding that the insulation resistance of the conductors at the factory was over 2,000 megohms per mile. There were about 40 joints in these conductors. Where these had been cut out and new ones made by an expert jointer, the insulation resistance rose to over 1,500 megohms per mile, and a very recent test of the same circuit shows it to possess virtually the same insulation resistance.

Under the methods once in vogue in other cities in this country with regard to underground work, in which no tests for defects were made excepting for such as would be indicated by an ordinary magneto, the circuit I have referred to would have been put into operation without question, and there is, I think, not much doubt as to what the outcome would have been.

The high tension electric light conductors are tested weekly for insulation resistance. The tests are made by the direct deflection method. A Thomson reflecting galvanometer being used, and as a rule 100 cells chloride of silver battery is employed as a testing battery. The tests are generally made from some room or basement adjacent to the terminals of the conductors in the subway, in order that the subway portion of the circuit may be tested exclusive of aerial portions.

At present the subways do not extend to the electric light stations, although in a very short time they will do so, as in the case of the Stanton street United States Illuminating Co.'s station.

When the conductors emerge from the subways they are run through subsidiary iron pipes up the side of a pole. From this pole the lead wires are run to the testing room.

The subway conductors are, as a rule, tested exclusive of arc lamps, converter, and inside wiring, but frequently also the tests are made inclusive of arc lamps and converters. These latter tests are only accepted when the results fairly indicate that the fall of insulation is due to the lamps or converters. In quite a number of cases the tests with converters included show an insulation resistance up to the requirements.

Tests of circuits are not made inclusive of house wiring because of the generally low results of trial tests. Some such tests that I have made showed an insulation resistance of the house wiring of less than 1,000 ohms.

The following records of actual tests may be of interest:—

Circuit A.—Arc. Initial test, 588 megohms per mile. Last test of same circuit, 388 megohms. Present length of circuit, 9.5 miles.

Circuit B. Alternating. Initial tests, 141 megohms. Last test, 1,250 megohms. Length, 9.6 miles. The first test was made when circuit was much shorter than at present, and doubtless the terminals of conductor were exposed during that test.

Circuit D.—Initial test, Jan. 6, 1889, 424 megohms per mile. Subsequent test, Jan. 2, 1890, 484 megohms per mile. Length of circuit, two miles.

Circuit E. Jan. 4, 1889, 1,750 megohms per mile. Same circuit, Jan. 4, 1890, 1,516 megohms per mile. Length, one mile.

Circuit F. July 7, 1889, 264 megohms per mile. Jan. 3, 1890, 343 megohms. Length, 6.6 miles.

The readings for these tests are generally taken after one or two minutes' electrification.

Tests with converters included in some cases, show very fair insulation. One circuit, with 34 converters included, showed 11 megohms insulation resistance. Another, with 11 converters included, gave a total insulation resistance of 159 megohms. It is not uncommon to get an insulation resistance of from two to five megohms with 30 and 40 converters in circuit. These tests did not include aerial portions of circuits. It should be said that the insulation of the converters and connections is being constantly improved; and, in my opinion, the time is not remote when the underground circuits will test up to requirements at all times with converters included.

As all of the conductors of the same company do not terminate at any one point, and the instruments have to be moved from place to place, the apparatus used in making the tests is of a portable pattern. The entire outfit can in an emergency be carried by one person, and very readily by two persons.

Contrary to the expectations of some people the actual making of these electrical tests has not been attended with any serious difficulty. The most troublesome factor has been that due to surface leakage at the battery or other parts of the testing equipment, during the very humid weather which prevailed so continuously last summer and winter.

The time for making these tests is, as far as possible, chosen to suit the convenience of customers. The majority of the tests are now made in the early mornings. All circuits are tested once a week at least.

About 130 miles of the subway electric light converters referred to are employed as carriers of alternate current for incandescent lighting. About 60 miles as carriers of arc light and incandescent continuous currents. The circuits vary in length from one mile to 11 miles, the longest arc light circuit is 10 miles in length; the longest alternating circuit is 11 miles in length. In 10 miles of alternating or arc circuit there are from 450 to 500 joints. The greatest number of converters on one subway circuit is 65. There are 14 arc light circuits and 25 alternating circuits in the subways.

Quite recently an alternating arc circuit has been installed in the subways which is intended to be the pioneer of numerous such circuits. I may say that it is ultimately intended to operate at least 125 lamps in such circuits.

LIGHTNING ARRESTERS.

In the case of many of the electric light conductors that were first laid in the subways of New York city, lightning arresters were used at street lamps and at the terminals of the cable, and in a number of instances the same apparatus is still used. These "arresters" are those known as the Acheson cable protector, and are intended to protect the cable against disruptive discharge from any source. The principle upon which the device is intended to act is that the disruptive discharges, or what would be the disruptive discharge, will jump the air space between the points of the needles, thus relieving the cable from the strain. The utility of this device for the purpose intended has yet to be demonstrated in this city, inasmuch as the frequency of burn outs in unprotected cables in the subways has been no greater than in those which are equipped with the protector, the percentage of burn outs on cables in either case being, as I have before intimated, very low. It is as yet, I think, an open question, whether the use of this or any equivalent device is warranted. There is no record of any of the cables in the New York subways having received injury from lightning during the past year.

It is commonly supposed that the freedom from burn-outs which the successful electric light cables in the New York subways have enjoyed, as compared with the earlier experience of other cities, is due to an increased thickness of insulation around the conductor. This may be the correct explanation; but the fact is worthy of attention in connection with this subject, that certain electrical condensers have for years been placed in positions where they are exposed to the full effect of lightning discharges on telegraph lines without, in a single instance, having sustained injury therefrom. Similar instruments have also been placed across the poles of 1,000 volts alternating dynamo machines for days without perceptible harmful effect. Since it is difficult to imagine a better opportunity for a disruptive discharge to effect its escape to earth than that presented by the extremely thin tissue paper used in those condensers, the thought is suggested that if this paper can be so constructed as to act as a barrier to the passage of such charges there may be more to be considered in this matter of insulation than the mere question of thickness of the insulating material.

ALLEGED DANGERS OF THE SUBWAYS.

The dangers to be apprehended from the existence of the electrical subways and from the placing of the "high tension" wires therein (according to those who are perhaps more or less inimical to that action) are varied. In general terms, they say, that the dangers which menace the public and employés from the presence of wires overhead will be multiplied manifold when the wires are underground. But when asked to specify those dangers the reply is limited to the following, namely, first, that linemen will be killed by coming in contact with live wires in the man-holes; second, that high tension currents will leave the subways and enter buildings by way of water and gas pipes, etc.; and third, that accidents due to explosions of gas in the subways will be numerous.

As regards accidents to workmen in the man-holes due to contact with live wires, no one will say that such occurrences are impossible, but inasmuch as not a single accident of this kind has occurred in New York city, or, so far as I can learn, elsewhere, in electrical subways, it is fair to assume that, with the exercise of proper supervision of the wires this is not likely to prove a frequent source of accident. I was present at the inquest of one of the unfortunate linemen who was killed last year in New York city by contact with an overhead wire, when a witness who had just made the statement that he apprehended more accidents from the placing of wires underground than had occurred overhead, was asked if he was aware that there were at the time about 100 miles of electric light wire underground in New York city conveying high tension currents and that not one accident had thus far occurred in the man-holes; to which he replied that this state of things was explainable in his opinion by the fact that the electric light wires underground constituted but one tenth of the electric wires of the city, and that when all the wires were underground the accidents in the subways would increase in the same proportion—which reply caused the foreman of the jury to remark that the public would probably not complain of an increase of accidents from nought to ten times nought.

I have already suggested in another place, that the fact of the wires being metallically covered may have conduced to the immunity from accidents which the workmen in the man-holes have enjoyed. I may interpolate here that it is recognized that the efficiency of the man-holes would in many instances be increased if they were larger, and whereever the surrounding condition of the street will permit, it is, I believe, contemplated to enlarge the man-holes.

So far as the statement is concerned, that danger is to be apprehended by the entrance of powerful currents into buildings by way of water and gas pipes, by contact of a grounded conductor in the subways, it would scarcely be worthy of notice before a body of electricians but for the persistency with which it is said to be urged by men of prominence in the electrical profession. It is conceivable that if a conductor, within a building, should by accident come in contact with a well insulated gas pipe also within a building, one might receive a shock by contact with the gas pipe if in some manner he should complete the circuit, but in what manner, in the event of a ground in the subways, any dangerous current can be conveyed to the inside of a building by means of gas and water pipes which have the entire area of the city's foundation as a ground or return circuit is more difficult to understand.

But whatever may be the dangers, stated or unstated, so freely predicted as liable to occur with the wires underground, it may certainly be said that with the electric wires underground men will not be injured by falling off poles in the subways. Wires when in the subways, during the prevalence of sleet storms, etc., will not fall upon people or horses in the street, nor be torn down by elevated railway trains, street cars, etc.

GAS IN THE SUBWAYS.

In my opinion, the presence of gas is the most serious defect of electrical subways in cities; of course it is not an inherent defect in the subways, but it is nevertheless a very troublesome one, not only because of the danger of explosion therefrom, but also because of its ill effects upon workmen employed in the subways.

As previously remarked, the ducts used in the subways are not only joined together as nearly hermetically as possible, but, except in the case of distributing ducts, they are laid in a solid body of cement from man-hole to man-hole. It is supposed that the gas obtains ingress to the man-holes through the place where the iron man-hole cover rests upon the masonry of the man-hole. But at whatever point the gas enters the subways its unwelcome presence is acknowledged, and while it is self-evident to any one who will investigate the matter for himself, and is actually admitted by the gas companies, that the gas emanates from the gas mains in the streets, nevertheless the subway engineers have been constantly at work devising means to remove the intruder.

To this end various methods for ventilating the subways have been suggested and tried, the most successful of which thus far has been the ventilation of the subways by the use of blowers stationed at intervals along the subways, and arrangements are now in progress to place 15 such blowers in operation to cover the entire subway system.

As the ducts become filled with cables, however, the free passage of air through them is prevented and in this way the utility of the blowers is diminished. In order to evade this difficulty, a six-inch wrought iron pipe has been laid above the subway ducts in the more recently constructed subways. This large iron pipe has openings at each manhole. The openings are graduated as to their extent as they recede from the source of the air pressure. The large openings are at the points remote from the blower. It is intended by the use of these large pipes to furnish a counter pressure in the subways somewhat exceeding any tendency of a pressure from the outside, rather than to produce a strong current of air through the ducts, and in this way to prevent the ingress of gas through any crevices that may exist in the subways.

It has been frequently suggested that good results might follow a suction method of ventilation, but experience has shown that this would rather aggravate the evil, as it would draw into the subway all the accumulated gas in the streets besides inviting a larger leakage from the gas mains.

The only beneficial effect to the subways of this resort to blowers to drive out the gas is that the air dries up the ducts and man-holes within quite a distance of the blowers.

The cause of these explosions in the subways has not in every case been definitely located. It is known that they are due primarily to the ignition of an accumulation of illuminating gas mixed with atmospheric air in explosive proportions; but the difficulty has been to ascertain by what means the gas has been ignited. It is on record that these explosions have occurred in sections of the subways in which there were at the time no wires whatever. And in cases where there have been live wires in the vicinity of an explosion, tests made immediately after the event have shown that those wires were in perfect condition as regards insulation. There are but three instances on record in which a defect in an electric light cable has occurred simultaneously with an explosion in the subways, and in one of these cases the defect occurred so nearly incidentally with the explosion that while it is quite possible that the defect may have caused the explosion, it, the defect, may have been due to mechanical injury due to the explosion.

Among other theories it has been suggested that the gas may be ignited by currents, induced in the lead covering of alternating current conductors. This might be the case if, as I have before suggested, the cables were supported from beam to beam, as on a bridge, on insulated stands, and if the lead coverings only approached each other at intervals, but where the lead coverings of the conductors are not only grounded throughout their lengths in the subways, but are also joined metallically, in fact are practically one cable in the ducts, it seems unlikely that a quantity of induced electricity sufficient to produce a spark could be accumulated at any one point.

In the case of at least two explosions in New York city, the evidence showed that the gas in the subways had been ignited by a lighted lamp or match in the vicinity of some subsidiary duct connecting with the subways. In other instances by a match or lighted cigar thrown in a man-hole. It is known that in Chicago an explosion was caused in the subways by a live coal from a passing fire engine, falling upon the cover of a man-hole.

With but one or two exceptions, the explosions have not injured the cables in the subways; which is probably due to the small and round surface which the cables present.

It has frequently been suggested that if solid ducts were employed instead of tubular ducts these explosions would be avoided. While this would be, if correct, a strong argument in favor of solid conduits, that is, ducts in which the conductors are not removable, notwithstanding the generally admitted fact that such ducts are not practicable for subway work on a large scale, experience has demonstrated that explosions have occurred repeatedly in man-holes and in small junction boxes of subway systems in which there were no hollow ducts.

I may add, that pending the installation of blowers in certain of the subways, men are employed day and night opening man-holes to permit escape of gas.

I had intended to comment briefly on the comparative expense of maintenance and reliability of underground wires in cities as compared with overhead wires, but as my paper has far exceeded the limits which I had placed upon it, I shall leave that and other features in abeyance for the present. Perhaps something bearing on those points may be brought out in the discussion.

The following are some of the rules of the subways of New York city which have been promulgated as precautionary measures or as a result of actual experience:—

No bare ends or bare portions of conductors, whether in or out of service are permitted in the man-holes. Every conductor in the man-hole is treated as though it were operative.

No joints except such as are protected by a metallic covering are permitted in the man-holes.

No lights are allowed in man-holes.

All conductors in man-holes are required to be arranged symmetrically around the walls and to be plainly tagged with the designating mark of circuit and the name of the owner. One of the pictures (which I have, by the courtesy of Mr. Beckwith, the chief engineer of the Subway company, been able to procure from his office) shows the cables passing through the man-hole in rather a haphazard way. This would do where there are but one or two conductors in the conduit, but when the conductors multiply, an orderly arrangement of them is essential.

No switch boxes are allowed in the man-holes. The reason for this is, that in the first place a switch box for each company would take up too much of the limited room; and secondly, in the case of electric light circuits it is feared that attempts to switch live circuits might produce dangerous sparks in the man-holes.

In conclusion, I think, it may be said that the experience derived from the practical operation of the electrical subways of New York city, has either made apparent or confirmed among other things the following:—

That it is possible to successfully operate all classes of electric conductors underground in cities.

That, at least for conductors conveying high tension currents underground, it is advisable to set the standard of insulation high.

That regular insulation tests of the conductors are very valuable.

That liberal thickness of insulation is desirable for high tension currents.

That it is unadvisable to place underground new types of cable or insulation until they have been subjected to tests and conditions analogous to those to which they will be subjected underground.

That for electric lighting conductors—especially distributing mains—many conductors under one cover are not advisable owing chiefly to the difficulty in making joints in such cables.

That all sharp edges in ducts should be avoided.

That until the gas light companies are required, like the electric light companies, to maintain their mains in a fairly sound condition underground, a means of ventilating the subways should be provided simultaneously with the construction of the subways.

And lastly, that while other features may be accessories thereto, the employment of smooth strong conduits, accessible ducts for distribution of the current, first-class insulation, constant expert attention to details and thorough organization in every department, are essential to the production of a successful electrical underground system.

ON MUSCULAR CONTRACTIONS FOLLOWING DEATH BY ELECTRICITY.[1]

BY PROFESSOR EDWIN J. HOUSTON.

Accurate data are wanting as to whether death resulting from accidental contact with electric conductors conveying the powerful currents employed in systems of electric lighting or power distribution is, or is not, practically instantaneous. Certain facts, however, are known which show that when the nature of the contacts is such that the discharge passes through the respiratory, the cardiac or the brain centres, that true physiological death, as evidenced by the complete failure of these centres to perform their normal functions, and their inability afterwards to perform these functions, is practically instantaneous.

In cases of death from a lightning bolt, for example, instances are on record where death has been so nearly instantaneous that the bodies have remained so nearly in the positions occupied during life that passers-by have failed to recognize the presence of death.

On the regaining of consciousness lost by a lightning discharge or a contact with an electric conductor, the subject, as a rule, has no memory of pain or suffering, and in many instances is even ignorant of the cause of the accident.

A fact, however, which appears to disprove that practically instantaneous physiological death follows a powerful electric discharge, should be alluded to. In some instances, it has been observed that the body of the person receiving the discharge, showed prolonged convulsive muscular contractions and contortions. The question thus arises, Do such muscular movements necessarily prove actual suffering on the part of the subject? Do they even necessarily prove the existence of life while they are taking place? While, of course, the answer to this question must necessarily be to a certain extent uncertain, the following considerations are offered to show that in all probability such muscular contractions follow physiological death, and are, therefore, unattended by consciousness or suffering.

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[1] Read before the American Philosophical Society, February 7, 1890.

Two general cases of contact resulting in death may occur, viz.:—

1. A momentary contact, where the discharge is only temporary, as in the case of the lightning discharge, or the case of a person falling against the wires and remaining in contact therewith but a few seconds or fractions of a second.

2. A prolonged contact where the current continues to pass through the body for some time after death.

In cases of death by the first class of contacts, no convulsive movements occur. Death results from physiological shock, or possibly from changes in the nervous or muscular tissues.

In the second class of contacts, death in many cases probably occurs practically instantaneously. The question then arises, How can the muscular contractions be explained?

The classic experiments of Galvani with the excised legs of recently killed frogs, prove conclusively that the passage of an electric current causes convulsive muscular movements. The same phenomena, too, have been observed in the human subject, as numerous experiments with the bodies of criminals shortly after their execution have shown.

It would seem, therefore, probable, to say the least, that when the electric current continues to pass through the body of the subject after physiological death has occurred, such convulsive muscular movements may occur, and that, therefore, their existence do not prove suffering.

When a powerful current traverses the body, tetanus occurs, and muscular movements in such parts cease. The nerve loses its sensibility, and, if the current is too strong, changes occur in its structure or composition, either as a result of polarization, or electrolysis, or otherwise, which prevent it from being further affected by the electric discharge. Since such changes presumably occur in cases of death by electric discharges, it would appear that muscular contractions would therefore be impossible after death. A brief consideration of the manner in which an electric current traverses the human body will show that such a conclusion is unwarranted.

When the electrodes of any source are applied to any two parts of the human body, a current passes through the body from a positive to the negative electrode. The density of current that passes, or the current strength per unit of area of cross-section, is different at different parts of the body. Those portions that lie in the paths of least resistance, which, in general, are situated in paths of least distance between the electrodes, receive the denser and more powerful current, while those lying in paths of greater resistance, receive weaker currents. In other words, in the passage of the electric current through the human body, a diffusion of the current occurs.

While, therefore, the nerves and muscles lying in the direct path of a fatal discharge may be almost instantly deprived of their sensibility by the passage of the powerful and fatal discharge through them, the nerves and muscles which lie in the paths of less powerful currents may still retain their power of electric excitation.

It is therefore probable, that in cases of prolonged fatal contact with electric conductors, the ensuing convulsive muscular contractions do not of necessity prove suffering.

I offer these views with some diffidence from the standpoint of an electrician rather than that of a physiologist.

.... FACTS form the wall around the fortress of knowledge against which the arrows of theories and false conclusions fall harmless.—*Foree Bain.*

Papers Read at the Convention of the National Electric Light Association, Kansas, Mo., Feb. 11--14, 1890.

SAFETY AND SAFETY DEVICES IN ELECTRIC INSTALLATIONS.

BY PROFESSOR ELIHU THOMSON.

THE development of the electrical arts, particularly in the direction of lighting and motive power transmission, has, in the past few years, been very great. It has brought with it a demand for very much work of a novel character, as regards the details of plant and methods of installation. It has also entailed, in many cases, elements of risk to life, and danger of fire. How far these risks have been or can be removed by proper attention to details and care in installation, has become an important subject for discussion. How far such risks have been increased by reckless installation of conductors, by faulty materials and supervision, it is not easy to determine. There can be no doubt, however, that electricity, as an agent, in itself is not to be charged with bringing about the results for which recklessness in its use is sufficient to account. That under favorable conditions for discharge through a person's body, electric currents of comparatively high pressure may injure or kill, is not to be questioned for a moment. I have no sympathy with any effort tending to impress a false estimate of such risks, or tending to give the impression that they are absent, when in reality they are existent. I have no sympathy with any efforts to exaggerate such risks, efforts which have not been wanting, indeed, as is well known. The fire risk, as well as the personal risk, involved in electric work is present in a greater or less degree, in accordance with the perfection of the work of installation and maintenance, the provision of the proper safeguards, and selection of the best conditions.

These are matters which are, every-day, of growing importance in all the electric industries, not even excepting telephonic systems and other such work, which, if badly arranged and not properly maintained, may cause crosses due to falling wires, etc., to become sources of danger, trouble and annoyance in the distribution of lighting or other currents. There is one fact which is of the greatest importance in this connection, and it is that safe installation means, also, good service. There can be no question that the risk to life *from shocks*, even with bad work, would be removed by not using high potential currents, as they are called, either alternating or direct. There can be no question, also, that a shock obtained from certain characters of current, such as an alternating current, is much less safe than in the case of continuous currents of equivalent pressures. Nevertheless, I am just as firmly convinced that the fire risk is very much less with alternating than with continuous currents of equivalent potential, assuming the work of installation equally good. The fact that it is difficult to sustain an arc, or rather that it is easy to select conditions which will prevent arcs forming with the alternating system, as compared with the continuous current systems of much less potential, is greatly in favor of the former. Hence switches, fuses, bad joints, ruptured wires, are much less liable to arc and incur risk of fire with alternating than with continuous currents. Would it be possible to work successfully, using only low potential currents of either character? Would we be able to utilize water powers for lighting, without employing pressure of potential sufficient to convey the energy to a distance over a conductor of moderate or non-prohibitive cost? In most cases we would certainly not be so able. Again, to utilize water frontage for cheap coal supply, and to employ compound condensing engines, to ensure small running expenses by massing the machinery at one station, to make use of railroad facilities, etc., in short, to work under the most advantageous operative and economical conditions, we *must* convey electrical energy by moderately high electric pressures, so as to avoid prohibitive losses or prohibitive cost of conducting wires. If ever our great natural resources in water powers are to be developed and utilized, it will be by the employment of comparatively great electrical pressures for conveyance of energy to distant points. If great saving of cost of fuel and other expenses in operating one large steam plant, instead of a number of separate plants, with their attendant risks, in large cities, is an object worth seeking, it will be found in the conveyance of electric energy at fairly high pressures. It must not be forgotten in this connection that even with very low pressure currents, safety from fire risk is only to be secured by careful construction and supervision, and that risk of fire often involves personal risk. Subway and underground conductors have caused man-hole explosions, with both low and high potential currents. Such accidents are generally explained by accumulations of coal gas formed in the man-hole and subsequently fired by the electric arc or spark of a leak. This may be and probably is sufficient explanation, but another may be given—the evidence of the possible correctness of which I have witnessed. A heavy leak or overheating occurring at some point of the conductors near the man-hole, may generate directly a large volume of inflammable gas from the distillation of asphaltum or other substance used as an insulator, and this gas, mixing with the air of the man-hole, may be easily fired by the heat of an arc or spark subsequently to its production, and cause a violent explosion. The remedy is thorough and continuous ventilation of the spaces in the man-hole and subway. An instance of a storage battery car being wrecked, from a similar cause, is on record. In this case the battery conductors were probably overheated by a short circuit and filled the compartment in which the batteries were with inflammable gases, and the further heating fired the mixture, the result being a violent explosion which greatly damaged the car. Such accidents always involve personal risks, and are to be prevented by simple means properly applied.

But the popular mind is so used to gas explosions that the newspapers have only a few lines to devote to them, while an accident in which an electric shock is obtained, although it has taken place through disregard of some simple precaution, is more than likely to be copiously provided with head lines and harrowing details. I even find one of the journals, whose name states its scientific character, attributing both the Lynn and Boston fires to electric wires. There is on exhibition at Lynn, as a curiosity, the oil stove which caused the fire, and inquiry into the cause of the Boston fire has, so far as I can learn, rather tended to discredit the theory than to confirm it. Notwithstanding these facts, it is true that under faulty conditions of lines or plans, fires may arise, and hitherto have arisen, traceable directly to the heating effects of electric currents. Perhaps if the accidents which happen serve to enforce the fact that the best work, the most thorough provision for emergencies, and careful consideration of details of electric work will be requisite to secure proper safety in the electrical field as in other classes of work, their mission will be fulfilled. Severe and inconsiderate as has been the dealing with the wire question by the authorities in New York city, yet it cannot be denied that the condition of the overhead circuits there had been, in the past few years, going from very bad to much worse. In many cases considerations of safe working would seem to have been neglected in the competition for business. The lines of four or five different companies competing in the same territory might be found, the result of this condition being, without doubt, to enormously increase the risks. There have been hints of the coupling up of dynamos in series, and so increasing the potential of lines already worked at too high pressures in relation to their condition of insulation, and to the placing of the lamps or other work supplied from such lines. Along with this we find the air full of telephone, telegraph and signal wires, of various sorts, none too secure from rusting out or breaking. Many of these latter wires could, no doubt, be easily buried underground, with advantage to the service, but it is certain that to attempt to bury the electric wires in a hasty, ill-considered fashion, merely for the sake of getting rid of overhead lines, would be productive of no good results, either in avoiding risks or bettering the service. The placing underground of very many of the wires now found overhead in our large cities is, in my opinion, a matter which must come in time, but it should be done carefully and gradually, so as to secure the best work. Meanwhile the re-organization of existing wires, the removal of unused wires or redundant wires, as where two systems or circuits in the same territory overlap while serving substantially the same purpose of supply and the use of first-class insulation on the wires would go far to securing safe working and uniformly good service. Besides all these precautions, and outside of them, wherever the conditions are and have been favorable to safe installation of overhead or underground circuits, there are to be found a class of appliances which are called "safety devices," inasmuch as it is their purpose to provide for abnormal conditions and remove risks which, with perfect working and maintenance, are usually absent, but may be brought into existence by accident or unforeseen defects. Such risks may be by outside interference with lines, or by lightning, by falling or poorly constructed signal and other wires upon overhead wires, by unusual wind or sleet storms, by failures of all kinds, as in the working of lamps, switches, etc. It is here that the safety device is found to be useful. Such devices are to the electrical systems what check valves, overflows, traps and safety valves are to hydraulic systems. There is, of course, no room for doubt that if the insulation of all parts of the plant, as dynamos, lines, lamps, etc., were maintained always at its best, and if the mechanical strength of lines, hangers, poles, etc., could be always relied upon, and further, if the effects of lightning induction were never present, there would be but little use for any purely electrical safety appliances, such as those for guarding against leaks and diversions of current. To expect such perfection of conditions is to expect too much. A rigid system of frequent testing can, however, go far to anticipate and to discover the departure from such safe conditions, and enable the disturbing conditions to be removed. Nevertheless, there will always remain opportunity for unskilled or careless handling so altering the condition as to provoke trouble; there will always remain chances of undiscovered defects, chances of interference from outside. The effects of lightning are an important factor during the thunderstorm season. I am driven to conclude, therefore, that safety devices are, and will continue to be, important factors in electric work. The more thoroughly they are adapted to their intended functions, the greater the security, and the more extended their application. That system of distribution will surely survive, which, while involving economy of first cost and maintenance, at the same time secures the greater safety and embodies the greatest flexibility. I assume, of course, that the running economy is practically good in every case.

In the very early days of arc lighting, with a single lamp only on a circuit, the idea of safety from fire or shock did not present itself. When such lamps began to be run in a series of eight or ten, or more, the need of an efficient cut out was felt, so that a defective lamp failing to feed its carbons should not burn with a long arc or flame, and so involve risk of fire, or extinguish the other lights. This need was met in 1876, by Lontin, who used the shunt circuit to actuate a shunting switch around the defective lamp. The Brush cut-out followed, and was a decided improvement on Lontin. Fuller and others early went over the same ground. The film cut-out, or shunting switch, depending on a small thickness of a high resistance insulator, such as oiled paper, to prevent its closure, which paper film is overcome by the difference of potential or pressure between the carbons when a long arc forms, was brought out by the writer, and later, the "vacuum cut-out," a modification which rendered the device self-setting for repeated action if needed. It is scarcely necessary to add that spark-catchers and enclosing globes with wire nettings, were early additions to arc lamps to prevent sparks reaching inflammable material near by, and the globe also in addition served to diffuse the light. Current regulators were additions to arc machines, and acted to prevent undue current, and secure thereby not only safety, but good service. The fact that good service in most cases is assisted by appliances which ensure the safety, or is even dependent on them, is a fact which ought not to be lost sight of in connection with the general subject of electric installation.

The early installations for arc light in and out of buildings, were made with bare wire circuits, and it is a satisfaction to me to recall in these days of forgetfulness of the benefits conferred by electric industries, and exaggeration of the dangers of properly installed plants, a case which occurred in connection with one of the earliest commercial plants of the Thomson-Houston arc lights in 1879. The machine of about eight or nine lights capacity, with bare wire lines, was put up in a large brewery in Philadelphia; two arc lights lighting the stables in which were thirty, or more, valuable horses. One evening a fire started in the hay-lofts in the story above, and where there were no lights of any kind used, and soon the flame and smoke spread to the stable room and menaced the horses. The proprietor happened to think to start up the electric lights at this juncture. Their brilliant rays saved the animals, which were removed without trouble, and the lights were kept burning during the progress of the fire. Its spread was limited by the efficient work of the fire department. The arc lamp globes were at times full of water, but, to the surprise of the firemen, the lights were not extinguished, but assisted them in their efforts very materially.

As the number of arc lights placed in a circuit grew, the necessity for thorough insulation was appreciated; the effort to secure which, for arc lighting lines, has resulted in very great improvements being made in the past few years. So far as electric wires go, the best "safety device" is a perfect insulation. In order that this matter shall not assume the condition of a trial of strength between armor and armor-piercing, as in naval affairs, with a constant growth of both, the advantage always being on the side of armor-piercing or insulation-piercing, I think that efforts to run more than a certain limited number of arc lights in series should be discouraged. Eighty, or one hundred lights, or even more, have been run and could doubtless be run safely under favorable conditions, but I doubt that such conditions can be found in city work, the interfering actions are too numerous, while the maintenance of good conditions would be too expensive. Without such good conditions there would be grave dangers involved.

It has become a practice to use incandescent lamps of low resistance in series on arc light circuits or other constant current lines, and much useful work is so accomplished. Here, again, safety from fire risk depends on certain safety devices, the most important of which is the shunt-forming device, when the carbon lamp conductor breaks. A number of very simple and effective devices are employed for this shunting action. Without such devices the tendency to arcing would be very great. It is advisable also not to rely on any one device alone for this purpose, especially if the lights are used indoors. Here the film cut-outs may supplement the action of a shunting device operated by the heat of an arc set up when the lamp carbon becomes discontinuous. These latter are the fusing cut-outs, twisted wire cut-outs, and others which connect the lamp wires together in the lamp, and so form a complete shunt. Other forms exist, notably the third wire cut-out, acting by diversion of current from the arc to a third or intermediate wire between the lamp conductors.

As in the case of the other devices mentioned, the perfection of operation of one, or a combination of several of these shunting contrivances, conduces not only to uniform service but to absence of risk. Absolute cut-off switches are now in common, if not in universal, use to cut-out loops of series circuits, and in a measure may therefore be regarded as safety devices, but not of an automatic character. Outside of these factors just mentioned, safety in such circuits rests in insulation and maintenance, avoidance of leaks, or crosses, proper placing of wires and lamps, avoidance of partial contacts or partial ruptures of the circuit at joints, binding posts or switches. In series circuits, the main object is to avoid a concentration of, or establishment of, large differences of potential at points in the line where the currents find or can find a path; in low potential, multiple arc systems as used in direct incandescent work, the object is to avoid concentration of current at points where such current cannot find a sufficiently low resistance path. Hence there is required cut-offs for current when excessive in any part of the system. Short circuits of accidental character must be provided against. If the safeguards are not ample, a more potent fire producer than a short-circuited section of an extended multiple arc system, is hard to find. Take out your fuse wires and replace them with copper wires, a practice, instances of which were not difficult to find in times past, and a short-circuit may quickly heat a long line of wire in a building, so as to set fire to the insulation of the wire and surrounding woodwork. The fusible wire cut-out, if properly made and used, is an effective preventative of such risks, though magnetic cut-offs are preferred by some, though more expensive. The magnetic cut-offs, which are simply open-circuiting switches, controlled by magnets in the branch or line so as to open it on excessive current, have the advantages of promptness, avoidance of the scattering about of fused metal, and can be reset without any renewal of material, so differing from the case of a fuse wire. Another risk in such systems is that of creeping of current from main to main over moist surfaces, or partial conductors, in amount insufficient to blow a fuse, but sufficient to convert enough energy into heat to set a fire. Good waterproof insulation of wires avoids this risk if the insulation remains intact. I consider the plan of running the two branch wires, excepting the larger ones of the system, near together or close together, as excellent in avoiding this risk, provided the wires are encased in insulation and covered in, or run in a tube. In case of a leak from main to main, the more quickly the fuses blow the better, and the proximity of the wires assists this speedy action, while between the wires there is not at any time enough combustible matter to set afire by the short-circuit. Enclosure in a tube effectually shuts off possibility of flame reaching combustible matter before the fuse blows. This does not apply to the heavier mains, capable of carrying thousands of amperes, so well as it does to the smaller branches. I am glad to note here that the tube or conduit system appears to be well worked out for inside wiring by the Interior Electrical Conduit Co.

Another thing to be avoided in extended systems of multiple arc work is grounding or leakage to ground of current over resisting surfaces or materials. The tube system is useful here as well, and the placing of two wires at difference of potential, near together, assists somewhat, but does not entirely remove liability of grounding. Testing for grounds in the system, taken in sections, is the proper procedure, although this does not provide against all suddenly formed leaks. It may be argued that in this case two grounds are necessary to cause a leak, one on each side of the system, and this is true, but in very extended systems of overhead work, more or less general leak exists which may provide sufficient current to feed, as it were, a local leak to ground from either main.

Let us now deal with what is called the alternating, or induction system of supply, in which the local, or house mains, are separate from the primary mains, and of much lower potential. For lighting purposes the system is very flexible, and enables distance to be overcome. The secondary circuit is, or should be, entirely out of connection with the primary mains of high potential, and the potential differences of the secondary circuit may be so low as to be incapable of giving a severe shock under the conditions of use, and to be almost incapable of setting fire, on account of the absence of arc forming tendencies. This is, indeed, an important factor in alternating current work, and conduces to the perfect working of switches and cut-outs, and the prevention of diversion to ground. Good work is all that is needed in this case to abolish all risks, if we leave out the main high potential current. The local line is unaffected by leaks or grounds at other parts of the system, and is, therefore, in this respect, in a better condition than is found with the consumer's lines in any direct system of supply. On the other hand, all the cases in which persons have received a shock from an alternating current of 1,000 volts or upwards, without being killed, are fortunate accidents, for there cannot be the slightest doubt that such current can and will kill under conditions favorable to its passage through the body. There are many cases of severe shocks having been obtained from such currents without permanent injury. On the other hand, there is a sufficient number of fatalities on record to sustain the position taken. The risks with higher than 1,000 volts alternating current are, of course, greater. It must not be forgotten, in this connection, that the actual potential differences in an alternating current of 1,000 volts are higher than that figure, and may be, at every wave, upwards of twice as much. This confers on such currents an actual and measurable striking distance between the two mains. As with arc lighting lines, the main or primary wires, if overhead, requires to be kept thoroughly insulated and free from leaks to ground. The covering for the wire should be capable of resisting moisture, and the wire used be strong enough to prevent any possible breakage. If the primary wires break and come down, they are still kept charged from the dynamo, which is not always the case with arc light lines. If, however, the insulation is strong and perfectly good, the risk to life is small in such case. There is one fact I wish to impress, however, and it is, that, with a parfectly insulated set of alternating primary mains feeding transformers, there still remains the static capacity of the line or cables and transformers, and this may be of an amount sufficient, if a person is grounded and touching the primary line, uninsulated, to give a severe if not a fatal shock. This inductive shock or discharge is, of course, far more pronounced with ordinary underground conductors than with aerial lines, and increases with the size and number of transformers and the extent of the line. It also increases as the voltage of the primary line is increased. Hence, it is quite important that no leak or connection exist between the primary line and a secondary in such system, or otherwise there may be a transfer of potentials of the primary line to the secondary so as to involve risk of shock to the consumer, or risk of fire from leaks to ground indoors. It will not do to say that such connections do not often form, for they may form from defects in construction, from moisture, and particularly from lightning discharges. A person standing on a damp floor, leaning on a steam radiator, touching a gas pipe grounded, or in other ways, may, if he handles or touches the secondary line at any part of it, be in peril of severe, if not fatal shock. What was without this condition a most harmless local line, becomes most dangerous.

The writer early recognized this danger, and felt that unless it was provided for, the induction system was not advisable for general use. As a consequence, the expedients of grounding the secondary, or of surrounding the secondary by a grounded sheath, or of cutting off absolutely by automatic means the local line when connected with the main line, or of automatic grounding of the secondary by insulating films or spaces which are punctured or overcome by the potential of the primary when connected with the secondary, were devised as safety devices. The grounding of the secondary is the most simple and effective if good grounds be made. It must, however, be done with certain precautions to insure the best results.

The second expedient of a grounded metallic sheath between the primary and secondary is persistently called "Kent's sheath" when alluded to by our English cousins, despite the fact that it is American in its origin. It is effective as a protector, as it carries to ground any discharge leaving the primary before it reaches the secondary. The sheath is easily made by placing a somewhat open wrapping around either the primary coil or the secondary coil of the transformer made of flat metallic ribbon or insulated wire, the ends of which are grounded when in use. The course taken by the wrapping is around the wire of the coils at right angles to its direction of winding. The automatic absolute cutting off of the connection between the transformer coils is also effective, and has undergone several modifications in other hands. The last protective device mentioned above leaves the secondary insulated from the ground until a contact or leak from the primary takes place, when an automatic ground is made. One of the forms consists in the interposition between the ground and the secondary coil or line of a film cut-out, or thin paper film between two metal buttons pressed together, one button connected with the ground, the other with the transformer secondary. This device is very effective in securing a safety ground connection of the secondary when the primary leaks to it. A well constructed transformer properly installed will not, except by accident, lose its insulation between primary and secondary, and such insulation should always be many times that otherwise requisite, so as to have a margin of safety; but the safety device is none the less a necessity in its use.

I consider that a properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also enclosed in a grounded metal case, as in the cellar of a building, a secondary line of low potential, grounded, or provided with safety devices as mentioned, embodies as safe a system of incandescent electric light distribution as can be devised, both as to risk to life and danger of fire. It ensures complete safety to all the consumers, and to each one individually. It enables long-distance work to be undertaken, and allows low voltage lamps to be used with their increased economy. The risks are confined to the electric station and the primary lines, which should be handled by men who know their business. The non-commutation of the current at the generators is another advantage, of course. The disturbing influences, which in the best organized plant may be introduced by lightning, are serious and sometimes destructive. It is not that the lines are *struck* by lightning that causes the trouble, but the mere *inductive* current or discharge from a flash of lightning is quite sufficient. It puts upon the line potentials of many thousands of volts and tends to break down insulation everywhere. Lightning arresters are, therefore, important safety devices in more senses than one. They save the machines in the station and the apparatus outside. In the alternating system they save from puncture the insulation between primary and secondary coils of transformers and between the turns of the primary coil itself. Every plant, then, should, if subject to lightning induction, be provided with efficient lightning arresters or dischargers.

A discussion of this general subject, however brief and necessarily restricted in scope, would be very incomplete without allusion to the subject of contact with telephone or telegraph wires with electric light conductors. Underground and in conduits such contacts could not easily occur, though leak might readily take place between lighting conductors and other wires. In any case, there is a risk of such wires carrying current into buildings or to positions bringing about shocks to persons, thus involving risk of fire or danger to life, or both. As a consequence a set of safety devices have been brought out under various names whose purpose is to cut off dangerous currents when they reach or traverse lines, such as those of the telephone or telegraph. It is my opinion that in cities the provision of approved devices of this kind should be compulsory. Most of those which I have seen are not well enough designed or made to be perfectly relied upon, but are much better than nothing and may possibly suffice. Such apparatus, however, should be made so as to be perfectly reliable and undergo a regular inspection. Mere fuses, even if made long, are not enough. There should be placed in every circuit liable to contact with lighting or such like conductors, and at a place in the circuit where it enters a building, a protective device which, to be complete, should shunt or absolutely cut off the section of wire indoors, or ground the same in case of abnormal current on the wire or abnormal potential.

There is much more to be said on this subject, and I am conscious of only having touched upon certain important matters in this paper. If I have succeeded in pointing the way to better conditions in any case, I shall be more than satisfied.

To sum up briefly, safety in outside work means care in placing, maintaining, and insulating conductors, whether used overhead or below ground. This means the employment of only good linemen, and not men who are ready to incur risks through a reckless disregard of conditions of failure to comprehend their importance. Men who have done telephone or telegraph line work are not necessarily prepared to undertake electric light and such other work with the best success. Safety in inside work means, primarily if admissible, separation of the inside circuit absolutely from the general supply mains, and in any case it means that good, careful workmanship is requisite, and that the employment of safety devices, amply sufficient to do the work required of them in case of accident, is imperative.

Safety from current entering buildings upon telephone, telegraph and other wires, means first, a more systematic placing of such lines apart from electric mains, whether above ground or below, guard wires and insulated wire for such lines, stronger wire, especially for telephones, and the employment of safety devices in case of accidental leaks or crosses occurring with electric mains, of either low or high potentials, and a periodical inspection by proper officers.

CONSTRUCTION OF CENTRAL STATIONS.

BY C. J. H. WOODBURY.

[Abstract.]

In co-operation with a committee of the National Electric Light Association, several years ago, it was necessary for me to examine the construction and surroundings of a large number of lighting stations. We found a diversity in their characteristics wholly inconsistent with their similarity of purpose.

The present paper is to be regarded as the opening of a discussion, hardly more, in order to bring the subject into a debatable form.

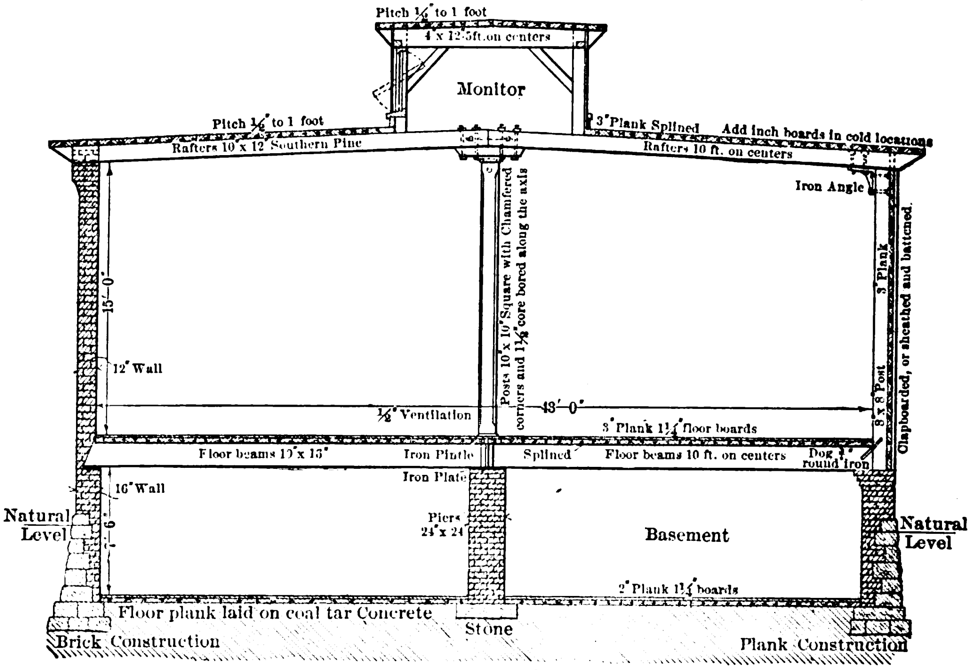
Many electric lighting stations in large cities have been built under easy financial conditions, where it was feasible to adopt suggestions for convenience, strength and safety. Notable examples of such stations have been presented before this Association, or illustrated in the electrical journals. The opportunities for large stations have thus far been so few, and the governing conditions so diverse, that the problem requires in each instance an independent treatment, and is, therefore, unsuited for a general paper on the subject.

The larger part of the electric light stations are of moderate size, and were constructed under conditions of limited resources which often compelled parsimony in the reduction of first cost, and did not permit the exercise of that judicious economy which yields the greatest return on investments.

A most important element in the arrangements of a central station should be the guarantee of continuous operation. Many of the stations are in close proximity to other buildings of a miscellaneous character, and are built with hollow frame walls and thin roof, forming a structure which is hot in summer, cold in winter, and combustible all the year 'round—which disadvantages diminish dividends. The location to be desired for a station is, first, away from other buildings, and, therefore, free from a fire hazard due to surrounding exposure. It is important that the engines should be provided with an independent condenser, but it is not necessary that the station should be near a water course. A reservoir of suitable capacity, will furnish a supply for condensers, which can be used over and over; the condensed steam and hot water entering one side of the reservoir, and the supply for the condenser being taken from the other.

In its general arrangements, a central station may be regarded as an engine room, and if well adapted to engines and the delivery of power there cannot be much difficulty in providing accommodations for dynamos. The type of building suggested for central stations in small cities, is the one-story slow burning construction, with flat roof, lighted by a longitudinal monitor, one end of which extends high enough to form a wire tower. It is not claimed that there is anything original in this design beyond a few minor modifications, for it is well known that beginning with one-story machine shops over 25 years ago, foundries, textile and paper mills, on the same general idea of construction have been widely introduced, wherever the cost of land was low enough to permit the erection of a one-story structure without raising the whole cost of the floor area, including the expense of land, to a price exceeding that of a high building.

Franklin once said that next to a good foundation, a good roof was the most important part of a house. The question of roof will next be considered.



The most convenient width for stations using an engine to every pair of dynamos is 43 to 45 feet, and the length of the station is in proportion to its capacity. The roof should be of three-inch plank, each 20 feet in length, grooved and splined with hard wood splines one-half by one and a half inches, and laid on roof timbers breaking joints every three feet. In colder parts of the country, it is good economy to lay a course of inch boards upon the plank, with roofing felt between. Pine is preferable to other lumber for roofing, as it does not warp much. The roof covering may be of any material for covering flat roofs, but its value will depend upon the quality of the material and the character of the work. If these methods are followed, such a roof can be relied upon not to give trouble by condensation of moisture in cold weather; but care must be taken not to drive nails up into the plank, because being good conductors of heat, the heads would be cool and moisture collect on them.

Along the middle of the roof, a monitor 10 feet wide, extending to 20 feet from the ends, will afford light and ventilation, while an extension of this monitor at one end to a suitable height will form a most convenient wire tower, if the monitor, in connection with an outrigger, should not be high enough for the purpose. The roof timbers should be of southern pine, 10 by 12 inches, and laid 10 feet on centres. They should project 18 inches beyond the walls, and the ends be cut to form brackets supporting the overhanging roof and forming a solid cornice. At the ridge, the two beams should be secured together by a junction bolt, and supported by column and bolster.

The walls of the station may be built of brick or of wood. If of the former, a 12 inch wall will answer; but if of wood, each roof timber should be supported on an eight by eight inch timber reaching to the sill, and secured to the roof timber by an iron brace, and to the floor timber by iron dogs.

If the building is to be used for low tension currents, the best floor would be made by laying coal tar concrete on a foundation of broken stone or cinder, and then laying three-inch plank upon the concrete, and covering this plank with one and a quarter inch hard wood plank laid across the bottom plank and blind-nailed to it. Such a floor would sustain any weight liable to be placed upon it.

If the high tension currents impose conditions requiring a higher insulation of the floor, such as can be obtained only by an air space underneath, then it may be necessary to lay a mill floor by placing the two thicknesses of planks on beams in a manner similar to that described for the roof. If the dynamos were placed on independent foundations, this floor would be strong enough, but if it should be required to sustain very heavy loads, there should be a line of piers supporting the beams under these loads. The lower portion could be made into a supply room; or otherwise, the front of the building could be divided by a light sheathing partition into a supply room and an office.

The building should be heated by two coils of three lines of 1¼ inch pipe, each hung about three feet below the roof timbers, the proportion of piping, using exhaust steam, being about one foot of 1¼ inch pipe to every 70 cubic feet of space. Two coils are suggested, because the side occupied by the steam engines would rarely need any heat from the pipes.

The roof timbers afford easy means of securing a trolley track for making changes and moving apparatus or parts of the engines.

The protection against fire consists principally in keeping the establishment in a clean and orderly condition, the use of good lubricating oil, and careful attention to the bearings; numerous pails kept filled with water, and hose connected to hydrants ready for instant use, will serve to put out incipient fire.

If the boiler house is placed at one corner of the station, the latter can be extended by increasing its length; but if the boiler house is placed at the end of the station, the division wall should be made of brick and extend through the roof, entirely cutting off all wood communication between the station and the boiler house.

The wires could be run from the dynamos diagonally upward to the roof timbers, clearing the trolley track, and thence under the monitor from beam to beam to the switch-board on the floor under the end of the monitor forming the wire tower. This switch-board would be at the end of the unavailable floor space used for belts, and away from the walls, where combustible material is likely to be placed. It is important that the switch-board should be made of soapstone or other incombustible material.

It is submitted that a station built in accordance with these general suggestions would embody the merits of convenience in operation, slight need of repairs, and, whether built with brick or plank walls, would possess a resistance to fire which would reduce the fire hazard to a nominal amount; and although not so cheap in its first cost as might be made by using a lighter construction, yet, as a whole, it would conform to the strictest conditions of economy in a building to be used for a central electric lighting or power station.

NINE YEARS WITH THE ARC LAMP.

BY M. D. LAW.

[Abstract.]

MANY irregularities in arc lamps can be remedied by a judicious study of their actions. To find the special trouble a careful record should be kept of each and every lamp. Give each lamp its individual number, firmly attached and never removed; then in a numbered book a page for each lamp, a record may be kept of all lamps, where they are, when changed, with the kind and amount of repairs. If a lamp is continually being changed for the same cause, there is some one thing that is radically wrong; this should be found and rectified. For instance, a lamp works perfectly on the test rack, but, after being in use a short time, has to be changed for dropping. If from the records this is found to be its general complaint, look for the trouble—if a Brush lamp, in the winding—that is, in the resistance of wire on the magnets. The resistance of the magnets should be kept as near as possible to 85 ohms; never allow more than three ohms variation from that amount.

If the following rules are strictly adhered to in putting together a Brush lamp, it will be found to burn correctly with but little adjusting.

See that the device carrying the lower carbon holder is parallel with the side rods; also that the screws, etc., at its base work freely and allow it sufficient lateral motion in all directions to affect adjustment.

See that the lower carbon holder is in line with its support, or the carbons will not centre.

See that the brass tube carrying the upper carbon holder is straight, smooth, and free from small or flat places, and that it moves freely in its bushings, which should not be too loose, as this will allow the carbon too much lateral motion, making it liable to slip past or wedge.

See that the upper carbon holder is in line with the rod.

This last adjustment is very important, and is made by clamping a steel rod of the same size as the carbons to be used in the holder, and revolving it between the thumb and the finger, noting whether the lower end of the rod revolves on its own axis or "wabbles," in the latter case, push the holder up to the lamp box, and, by means of the testing rod, bend it slightly in the proper direction to correct the error, then see that the carbon holder has not become loosened; test again, repeating the process until the desired adjustment is reached.

Examine the lifting washers which surround the carbon rod, see that the hole is counter-sunk on each side, so as to make the available thickness of the washer where it touches the rod but little more than a sixteenth of an inch. See that the hole in the washer is of such a size that one side of the washer may be raised one-sixteenth of an inch from the horizontal floor on which it rests, before it clamps and commences to lift the rod. See that the holes in the washer and bushings are nicely polished. The lifting finger, designed to lift the washer, should move freely in its guide and get a good hold under the edge of the washer, and allow the latter to rest flat on the floor under it when the finger is down. In the case of double lamps, the lifting finger should be so adjusted as to lift the second rod one-sixteenth of an inch ahead of the first.

See that the movable brass parts connecting the lifting finger with the movable magnet cores work freely at their joints, so that no binding of the parts may be possible.

See that all the parts of the dash-pot are free and do not bind. See that the armature of the cut-out moves freely on its pivot.

In the Thomson-Houston lamp the clutch should be of german silver or some more durable metal than brass, as the bearing point of the clutch against the rod is so small that it very soon wears and thus throws the lamp out of adjustment. When one of these lamps is found dropping, it can very often be remedied by lowering the adjusting nut (No. 692) a trifle, when the lamp will again burn correctly.

Another improvement in this lamp is, increasing the thickness of the insulations, which are too small in nearly every case; especially is this so with those under the binding hooks at the top of the lamp box, which I find work excellently well made of porcelain.

The general causes of the Thomson-Houston lamps dropping are numerous; but if all the working points move freely and without lost motion, it will reduce the number to the few following points: Badly worn spots in the carbon rods, this is a common fault of all arc lamps. The clutch or lifting spring may have lost their temper, these should be made of bright instead of black steel. Clutch arm bent. Clutch or carbon rod bushings may become worn. The adjustment nut (No. 692) may be too high or too low, the clutch or tension spring may be too tight. Crooked frames, bent rods or rods striking the chimney, tight bushings, fine wire broken, dirty rods, brush in the bushing may be too tight or become corroded or burned, and the magnetizing of the armature before spoken of will cause the lamp to flame and drop.

With the United States or Weston lamp the principal cause of trouble is the tripping from first to second set, and when this happens so that the second set burns first, it generally means a new set of contact springs and new magnets if the lamp burns entirely out of carbons. Some of the causes for tripping are: rod sticks or wants new contact brush, lever hook loose, rod scrapes chimney on first set or too much hook on first set, adjusting screw on long hook set too high, lost motion in rocker shaft. Causes of long arc are, platinum collar dirty or worn out, trip lever sticking or too loose, carbons not burning in proper proportion, burning holder before the carbon rod is down far enough to make contact with trip, small hook dirty, rod crooked near the top, weak magnet, fine wire burnt, clutch holder or armature sticks, rod a little thick at the top and brush too tight. Causes for dropping out are: weak magnet either fine or coarse, lost motion in rocker, stiff clutch, too much clutch, not enough clutch, slight nigger in coarse wire, plunger too stiff or too loose, plunger bent, broken or crooked plunger rod, bad carbons, which may on starting become soldered together and cannot lift.

The globe holder or carbon holder of arc lamps is a very much neglected part—that is, the insulations are not made heavy enough, but that the carbon dust or copper droppings falling over the insulations will give such leak that a person standing on the ground and touching the bottom of the lamp may receive a very bad shock; this insulation should be made heavy and so placed that the carbon dust may not fall on it, for it is sometimes impossible to hang lamps under awnings so high that a person passing under may not touch them with an umbrella or other conductor. No part of the lamp outside of the globe should be allowed to have current in it. Arc lamps should be suspended by some perfect insulator, the regular porcelain insulator and hook being the best in our experience; this is a very important point and is often neglected. Dirt must not be allowed to accumulate on any part of the lamp; rods, switches, bases and globes should be kept well cleaned, and all binding screws kept tight, the rods should be kept thoroughly well wiped every day with a clean cloth or waste; never allow crocus or emery to be used, they badly wear the rods in the middle.

Our longest record for any one lamp in a constant street service is three years and nine months without any adjustment other than the ordinary cleaning by the trimmer.

In order to get a good lamp record, no lamp should leave the test rack until it is perfect in all parts.

The most vexatious part of the arc lamp is the globe, it swells the item of expense in spite of the utmost care, besides being a great source of complaint. I have found that it pays to put wire nets (which should be made of copper) on all globes, even for street lighting; this prevents pieces from falling out even after they are badly cracked, and if the globe entirely gives way, the net will prevent its falling on some one's head. Undue heat after the carbon has burned close to the holder, is one of the greatest causes of broken globes. This can be partially overcome by leaving the globe about one and one-half inches from the carbon holder.

A serious point in station management is the pay-roll. Two men more than are necessary will cost nearly as much as a ton of coal per day, and thirty tons of coal per month would be quite a saving. While keeping the number of men as low as possible, none but first-class men should be employed. Especially must trimmers attend to their duty well, as the quality of their work controls the amount of rebates to be allowed disgruntled customers during the month. Another important man in this respect is the dynamo man. He should give the dynamos the most assiduous attention, that the strength of the current may be kept constant, while flashings and interruptions may be reduced to a minimum; for no matter how well every other department of a station is carried on, if the current is allowed to vary from the standard, complaints will follow, and they are expensive.

There is nothing that angers a user of electric lights so much as to have them flash; it may be only one or two seconds that they are out, but it always seems like a much longer time, especially if in a crowded hall. Rather have the record for continuity of lights so good that the gas fixtures may even be removed; this can only be gained by close attention to the machines, wires and lamps.

I call to mind one place that we have lighted continuously, without any other method of illumination than arc lamps, for over eight years, and during that time the lights have never been out during lighting hours.

The waste in the use of carbons is a very important feature. These should be dealt out and every stump returned; the amount saved in laying by the four and five inch stumps to be used in the summer months will make a saving of at least 10,000 carbons per year for a 1,000 light station.

At the time I first started dealing out carbons and bringing in stumps, I saved on an average over $30 per month, and then only trimming about 400 lamps per day.

An arc light wire should never be concealed.

The use of soft rubber tubing for passing through floors, ceilings, walls, etc., should never be allowed, the only suitable material for such work is hard-rubber tubing.

While I am a great believer in the use of the best quality of insulation for line construction, yet it is not best to depend entirely on such insulation for safety. Put up the best wire there is, and then apply a rigid system of inspection and tests—not by that abomination of tests, the magneto bell. Not only should the tests be made on dead lines, but they should be made at least once in two hours on all live wires, and when grounds or bad leaks are discovered, they should be immediately cleared, by that means forestalling the second ground, which is the element of danger. I have repeatedly had lines that would test clear at the time of putting on circuits; but two hours after, solid grounds have been discovered, located, and found to be wires broken down, hanging over the electric light wires and reaching down to the sidewalk, where they are a source of danger to every passer by; besides every boy that passes must feel of it to see if there is any electricity in it. My orders are to clear grounds at once, dropping all other work that is not absolutely necessary.

In Philadelphia we receive great help from the electrical bureau of the city, through their prompt reports of all wires discovered in contact with ours.

All lines should be cut by one man, who is especially instructed and detailed for that work. Teach every employé never to depend on any insulation, but to treat all wires and lamps as if they were charged with an electric light current; dangers to employés will thus be reduced to a minimum.

HOW OUR PATHS MAY BE MADE PATHS OF PEACE.

BY H. W. POPE.

[Abstract.]

PREVIOUS to the introduction of the telephone, the standard of out-door or pole line construction may be said to have been that established by the Western Union Telegraph Co. The lines were never of a superior character, nor comparable with those in European countries, and it was not until after thorough inspection and exhaustive tests were made by a prominent English electrician, employed for the purpose, that extensive alterations and improvements were made.

The construction of an excellent line on the route of the Pennsylvania Railroad, between Jersey City and Philadelphia, by the American Union Telegraph Co., marked a new era in line construction, but the standard thus established was never closely followed by telegraph builders generally.

To those of us who have been identified with electrical interests for the last quarter of a century, there seems to have been no notable improvement in telegraph and telephone line construction, except as shown in the recent interstate lines of the American Telephone & Telegraph Co. The introduction of the telephone brought into the electrical field a very large class of workers devoid of electrical knowledge or experience. To this class, the methods employed and the standard of construction prevalent, were superior to the necessity and requirements of the telephone. This opinion and the lack of sufficient capital to exploit properly the telephone business was primarily the cause of the introduction of poor material and workmanship, as well as the small wire and insulators, together with porcelain knobs and cheap insulation.

With the experience of our predecessors in the electrical field, and with the knowledge of the character of the current we were handling, it would seem as if a superior character of construction and insulation would have been deemed imperative for electric light lines; yet, with the exception, perhaps, of conductivity, everything has been inferior to that previously used by corporations employing harmless voltage. That such was the case is due somewhat to causes similar to those prevailing in the introduction of the telephone—but the use of cheap insulation, what is popularly and properly known as "undertakers'" wire—was due wholly to the ignorance and stupidity of underwriters' officials, to whom many of us protested repeatedly against its use.

The accumulation of poles, the inferior character of the materials used, and the utter disregard of public considerations or the character and beauty of the surroundings, gradually moulded public opinion against poles and wires in general, and electric lighting in particular.

The desire of electrical manufacturers to crush their competitors, distressing accidents, and the publication throughout the land of magnified accounts of the dangers of electricity, depreciated our property, and retarded the progress of electric lighting and electric traction to a great degree. To this condition of things we must now devote our attention—adverse legislation is cropping out in nearly every state in the Union, tending to regulate voltage—to bury the wires, and to accomplish other reforms. In view of this, it should be the aim of electric lighting corporations to so reform existing methods of construction as to show a decent regard for public opinion as to safety and the appearance of structures. By a sincere effort in this respect, beneficial improvements can be introduced without necessitating large expenditures, and the clamor for the removal of overhead wires reduced to a minimum. Where there happens to be an unnecessary aggregation of poles, endeavor to perfect an arrangement whereby poles may be occupied in unison, and many poles can be removed. Such a course will reduce your maintenance expenses, and create for you favorable public opinion. In the erection of poles, considerable attention should be devoted to their design and proportions, and the character of finish, to the end that the structure may be pleasing to the eye. The question of expense, as compared with common poles, should not be allowed to deter you from the ultimate purpose of replacing your entire line, especially in cities or towns where the burial of wires would be a financial impossibility.

To those familiar with the recent excellent structures of the Long-Distance Telephone Co., or those of some of the electric railways, the manner of improving upon the present methods of construction will readily suggest itself. While it is not advisable to use iron poles, combination of wood and iron can be used to advantage in many instances. It will be frequently discovered upon investigation, that lines of poles erected in the streets in front of buildings can be removed to an alley or street in the rear, or run over private rights of way by the payment of a nominal consideration. Provide every pole with iron steps; paint the poles as thoroughly as you would a house; and select colors that will not make your poles conspicuous.

In so far as a neat, well-designed and substantial brick station reduces your rate of insurance, gives character and substantiability to your investment, so will the improvements suggested—however small and insignificant at first—if properly carried out, win for you favorable consideration and fair treatment, enhance the value of your property, and tend to postpone indefinitely the removal of overhead wires.

It should be the aim and policy of all electrical corporations constantly to improve the condition of poles and lines—giving as much attention to their strength and beauty as to their perfection electrically. The assumption that such a course is unwise, because of the theory that sooner or later all wires must be buried, is wrong, because it is questionable whether such an extreme will be reached, especially in cities and towns of small population. Every day that you delay these improvements you encourage adverse criticism and hasten adverse legislation, state and municipal.

DEVELOPMENT OF GENERATING STATIONS FOR INCANDESCENT LIGHT AND POWER.

BY C. J. FIELD.

I DESIRE to present a brief review of the present and near future of central power plants in the larger cities, taking as an illustration one of recent type, describing its general arrangement, then proceeding to the consideration of its initial cost, earning capacity, output, operating expenses and economy, and in conclusion, trying to indicate the immediate future development in this class of work.

The immediate points to be considered in the designing of central power plant for a large city are many, and they should receive careful survey before any work is proceeded with. We will briefly summarize them as follows :—

First. Recognition of the importance of safety and reliability in operation.

Second. Obtaining the true economy of output under all conditions.

Third. Installing of plant in a building entirely suited to the working of same, and as far as human ingenuity can provide proof against destruction.

Fourth. Adaptability to proper and economical working of the plant.

Fifth. Division of the generating power into the proper number of units for the safe and reliable operation of the plant.

Sixth. Flexibility of system, that is, adaptation to furnishing current for light, power and other sources of revenue, the obtaining of the largest return per dollar invested, and not carrying to excess for the mere sake of engineering by any part of the plant for the obtaining of proper results therefrom.

Seventh. Not installing the plant for mushroom growth, but laying it out for comprehensive business, thereby securing, at as early a date as possible the entire confidence of the invested capital.

A careful consideration of these points will prevent trouble later on. Much of the trouble of stations at the present time, in their standing with the community, is due to neglect of this point, and the majority of their failures as well. We must recognize the fact that the public, to a certain extent, have become prejudiced, somewhat unjustly, but this is all the more reason for better and more conservative management, and good construction. No more inviting field is offered for either investing capital or good engineering than central station for lighting, power and railway work.

I propose to take as a representative type, showing the present development and first-class work, the station of the Edison Electric Illuminating Co., of Brooklyn, completed last fall and now in successful operation.

In the arrangement of this plant there was somewhat of a departure from previous general practice, the company trying to secure the benefit of past experience in the larger stations of this class, both in the kind of arrangement and of apparatus used, trying to secure at as economical a cost as possible, the best plant. As will be seen by the longitudinal section through the building, the general arrangement is as follows :—

The boilers and engines are located on the first floor, the engines being on the front half and the boilers at the rear, thereby bringing everything on this part directly under the eye of the chief engineer, making it much better than where the boilers are located two or three stories up; this was obtained by spreading out a little more on the ground. The boilers are Babcock & Wilcox's largest type of sectional water tube boilers. The engines are 300 h. p, compound, horizontal, automatic engines, manufactured by the Ball Engine Co. Each engine is directly belted to two generators. The plan of the engine and boiler room floor will also show in more detail the general arrangement here used, and, I think, needs no further explanation.

Ascending to the second floor, we reach the electrical part of the plant. Here are located in the front part of the building, directly over the engine room, twenty-four dynamos, each with a capacity of 750 amperes and 140 volts. Each dynamo weighs about eight tons.. Overhead traveling cranes are installed here and in the engine room for ready and quick handling of all apparatus. Through the centre of the dynamo room is located the electrical gallery. From here are controlled the workings of all the dynamos and other apparatus, also all outside lines; everything in connection with handling, generation and furnishing of current, is directly under the eye of one man in this gallery, and from which he has a general view of the dynamo room floor and the workings of the dynamo, a second man being on the floor to see to the bearings and brushes. From this gallery run all the feeders, which connect into the net-work of mains, covering over an area of about one and one-half miles square. The ampere meters are located on each feeder, so as to show the load in each part of the district. This plant maintains its distribution and regulation thereof by balancing within itself. No feeder equalizers are here used for feeder regulation ; the uniting and tying up of the system together with the use of the auxiliary bus affects this regulation. All circuits of this plant are underground, there being about twenty-five miles of underground conductors. These have given perfect satisfaction and reliability in their workings, maintaining to-day an insulation on the system as a whole of over half a megohm.

On the rear of the second floor are located the coal storage, water tanks and feed water heater. On the top floor we have the offices, supply rooms and workshops of the company. Returning down stairs again, we find in the basement, ash pits, smoke flues, pump room, two large coal storage vaults, giving a total capacity for storage of over 1,000 tons, air blast for force draft, and other details in connection with the steam plant.

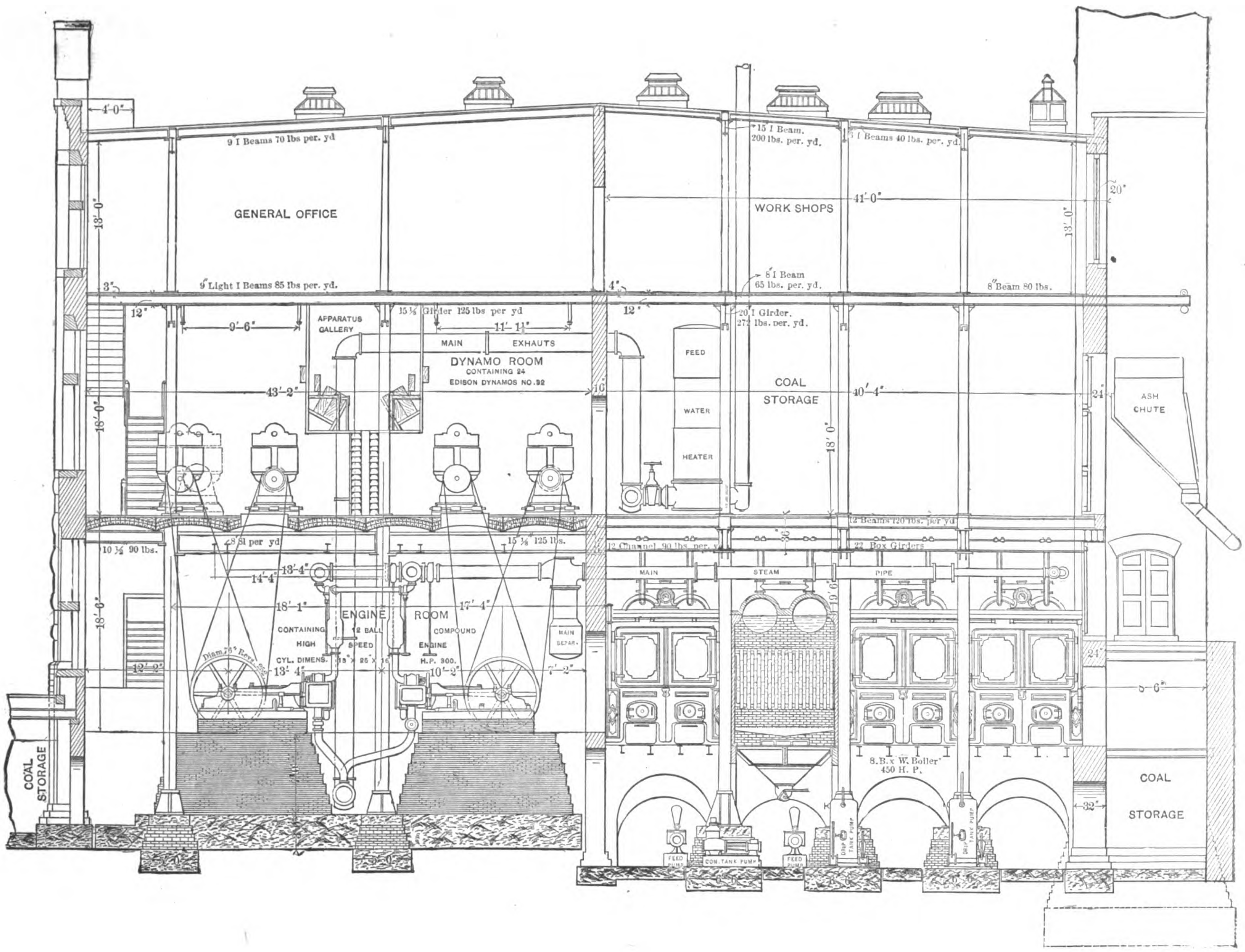
We have, therefore, here, in a building 75 x 100 feet, apparatus and all departments complete for the generation and supply of current of 40,000 lights, or the equivalent in light and power, and so arranged as to secure, as far as can be foreseen, continuous working of the plant and entire reliability in the supply of current. I give you now, in round figures, the cost of this plant as shown by the construction accounts and estimates :—

Station building, complete, including all fittings, foundations, stacks, furniture, etc.	$100,000
Real estate	36,000
Steam plant, including engines, boilers, pumps, heaters, piping, bells, etc.	50,000
Electrical plant, including dynamos and all electrical apparatus, as switches, etc.	40,000
Underground system, material	115,000
Excavation and labor installing same	35,000
General, including lamps, meters, tools, instruments, engineering and architectural expenses, wiring, services and office furniture	50,000
Total	$426,000

This includes the entire cost for the plant as it stands to-day, which as far as the building is concerned, is complete for the entire capacity. At present there is installed generating capacity of boilers, engines and dynamos, for one third (⅓) of the final output of the plant. The subsidiary electrical apparatus is complete for the entire output, with a very few additions in the way of a few switches, etc. The underground lines have a capacity for 20,000 lights. The work necessary to complete the plant for its entire capacity would cost about $200,000 additional.

For this amount there has been obtained here a plant, which is considered equal, if not superior, to any of this class, and at a cost of twenty to thirty per cent. less than has been expended for similar ones.

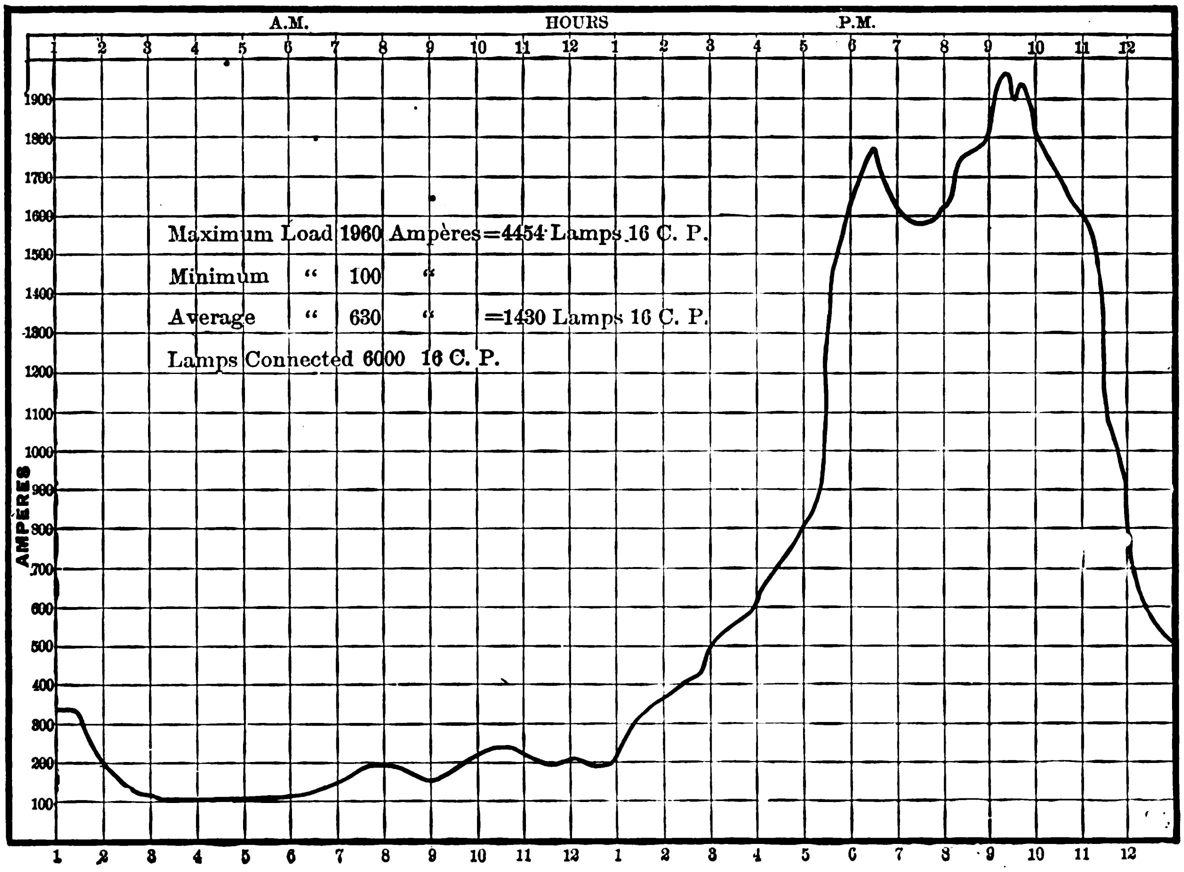
The next consideration is the operating expenses. To place the company on an earning basis we have to secure to start with, a certain number of lights or an equivalent in lights and power, to clear the necessary general and operating expenses, which will exist regardless of the smallness of the load; in other words, we must have for such a plant not less than 5,000 lights with an average income of $8 per light per year to clear the general incidental and operating expenses. This figure we may consider as our unit of operating capacity. From this we can figure the increased earnings and profits for the larger number of lights connected. There exists, practically, a constant ratio of variable and fixed operating expenses. By variable expenses we mean those obtained on a variation in load and increase of business; this includes coal, oil, lamp renewals and small increase from time to time in the amount of labor employed. The fixed expenses include those items which remain practically constant under varying conditions of income. A careful analysis of all the items covered in these expenses in such a station as this one, gives the following result : That the fixed expenses are seventy-five per cent. of the whole, and the variable twenty-five per



LONGITUDINAL SECTION OF BROOKLYN EDISON STATION.

cent. approximately, or in language which may appeal more directly to you, if we double our income or business, we only increase our expenses 25 per cent. This shows that a station's possibilities and profit lie in increasing this business from the unit point.

We have illustrated a load diagram taken from this station, which gives you a fair idea of the changes and variations. The maximum number of lights lighted at any time in proportion to the number connected is very good for such work and shows a good class of business. The load diagram through the day, however, shows a new station on a clear day with a small number of lights lighted, and power work only just commencing. It is this power work that wants attention and the securing of which means the bringing up of this average load during the day-time to a good paying basis. The curve for the evening hour indicates a good, broad, solid load, which shows the combination of six o'clock business, with the addition of a good solid evening load. Many stations after reaching the maximum point around six o'clock, rapidly fall off and never regain this point again for the evening. Here we have the illustration of clubs, theatres, churches, concerts and residences, lighting after supper, bringing up the load to its maximum point between eight and nine o'clock. The average load for the twenty-four hours, which is about twenty-five per cent. of the maximum, is a very fair one, and with the addition of the day load that will come on with the addition of power, will make this a model load diagram. The general run of stations shows as an average for the twenty-four hours, from twenty to forty per cent. of the maximum load ; the latter figure is very seldom reached. The writer knows of one station in which we have the latter figure, and where, if we eliminate one short half-hour around six o'clock A. M., we have the remarkable showing of seventy-five per cent. average load for the twenty-four hours. As to the workings of the engines in this station, indicator cards from running tests show the division of work on the cylinders as follows :—



LOAD DIAGRAM OF BROOKLYN EDISON STATION.

I. H. P. head end high pressure cylinder	........$63\frac{8}{10}$	h. p.
" crank end " " "	.......$60\frac{2}{10}$	"
" " low " "	...... $59\frac{2}{10}$	"
" head end " " "	.......$55\frac{2}{10}$	"
Making a total, I. H. P.	....$238\frac{4}{10}$	h. p.

with a boiler pressure of 110 pounds, revolutions 223 and load 1,200 amperes, which is the equivalent of 2,725 lamps, therefore giving for the indicated power furnished, eleven and one-half lamps per horse-power. This is for power developed, making no allowance for friction of engine and dynamo. The friction of the engine is less than 5 per cent. of its normal capacity.

Having in the above given a general outline of this plant, its cost and operating expenses, I now wish to call your attention to the points in connection with the type of engines, boilers, dynamos, underground system, etc., to be adopted in a station of this class.

In planning the engine power of a station of this kind, we first have to consider the question of using either the Corliss or high speed engine. Regarding the use of Corliss engines, we are frank to state our objections. Excessive first cost, ponderous machinery, counter-shafting, pulleys, clutches, etc., lead us to believe that these things are unnecessary when the problem is carefully considered from an unbiased standpoint. Assume for the sake of argument, that we can save five or ten per cent. in steam economy, if this is obtained at a cost, the interest of which amounts to more than this, we are obtaining it for no good whatever ; furthermore, there are many other problems in electric light stations which we have to carefully consider in this question of steam plant, one of which is reliability in operation, and being always ready for service. We should not design our plant for that capacity reached as shown on our load diagram, for only a short time in the twenty-four hours, but we must so design it to give this result for the average, that we have during the twenty-four hours. Even where we have a more constant load, as in exclusive arc lighting on municipal circuits, I think even here we need to carefully consider the problem as well.

High speed engines, so called, although they are not in piston speed any higher than the Corliss, but merely in rotative speed, have shown a considerable development and marked advance in the past year, and the next year is going to see even more development in this line. Owing to better workmanship, better designing and building than formerly, the prejudice which largely existed among old engineers against this type of engine, is rapidly wearing away. With the single cylinder engine under variable load we often obtain poor economy, but as compared with the Corliss, under similar conditions, allowing for the discrepancy in price, the result is not so disparaging. Now they are going further, and building compound and even triple expansion engines of this class. In the Brooklyn station we have one of the representative types of this class of engines, horizontal, compound engines.

These engines are built for high economy and economical work, and the guarantees made on them, I think, compare favorably with the guarantee on compound Corliss engines; at least three or four of the manufacturers of this class of engine stand ready to-day to guarantee from twenty-two to twenty-five pounds of water per indicated horse-power per hour. I do not know of any Corliss manufacturers who are willing to do any better. Engines of this class are as well built now in workmanship, and as reliable in operation as can possibly be desired. Added to this, we have the advantage of direct connection to our generators. Tests made at the Brooklyn station have shown that the engines have actually come up to the guarantee made on them, and that the plant there is showing, as compared with single cylinder engines, an economy of coal per unit of output from twenty-five to thirty per cent. better. In a station of this kind, the actual coal consumed per unit of output at the dynamos is considerably larger than is shown on a direct test where we charge the engine only with the coal it uses directly. The weekly records from stations of this class charge the horse-power output with all the coal used by the engine, pumps, condensers, well pumps, cleaning fires, blowing off boilers, etc., and where the former item is about three pounds of coal per horse-power per hour, we have in the latter case, making no allowance for the engine running empty, a result fifty per cent. greater than this. Economy in this line, however, is not going to stop at compound engines, as there are being built by at least two manufacturers, triple expansion high speed engines.

In connection with the triple expansion engines mentioned, we have to consider, again, the problem of the dynamos to be used. We can stay as at present, and belt to our dynamos, but I believe that the next large incandescent stations will not only include compound or triple expansion engines of 300 or 400 h. p., but will also have multi-polar dynamos, one or two being directly connected to the engine. By this I do not mean belted, but direct shaft connection through a flexible coupling. This, of course, necessitates the multi-polar machine, in order to secure the output with a slower speed. Engines and dynamos of this type can be installed in the space at present occupied by the engines alone. This means not only economy in building and real estate, but also in operating expenses.

In regard to boilers for such a plant, we do not know that we have any new economy to be hoped for in the near future. All we have to look for at present is improvement in detail of manufacture and the securing of better and dryer steam. We have two classes of boilers prominently before us for this work. We have, in general, first, horizontal tubular boilers, which we find in general factory use, to a large extent, throughout the country. Where we have plenty and cheap real estate, poorer attendance and moderate steam pressure, this class, in general, fills the bill. We find, however, that they are now even building them to work up as high as 125 pounds boiler pressure. When we come to construction of the boiler plant on expensive city property, where we are cramped for space, we are almost limited at once to some one of the types of sectional water tube boilers. In the Brooklyn station, we are practically limited to the consideration of this class, and we have not only 125 pounds but 150 pounds boiler pressure, and even higher. We have also the advantage of quick steaming under heavy changes in load.

We have to-day, brought before us in the underground systems, the consideration of what is to most of the companies their most serious problem, in the proper solution of which the best talent is being devoted. In the Edison underground system we have what is generally recognized as the most practical solution for circuits of less than 500 volts. We here obtain at a minimum of cost the most flexible system and local distribution from house to house, which has no equal. It enables you to take off services for local distribution from every twenty feet without in any way affecting the insulation on the main line, and being able at any time to disconnect these services and restore the main to its original condition. In any other system we have the problem of splicing and cutting of cables, which, at its best, is bad work. What we desire is not such a high insulation, as good, mechanical protection. As long as we can hold a moderate insulation with good mechanical protection, that is all we want. In Paris they have used bare copper conductors, supported on porcelain in a concrete conduit. This has worked satisfactorily in the main so far, but, of course, are very expensive. They are now proposing for all their increase, the Edison tubing for this class of work. In any system of cables drawn in we have the selection of a large class of conduits, but in my mind all we need and desire, as I have before stated, is mechanical protection for these cables, and the cheapest conduit that will afford this protection is all that is necessary. What is wanted especially is some system of local distribution for these higher tension circuits. The underground system installed in Brooklyn has a network of underground conductors in the mains and feeders of over twenty-five miles. This entire system is so arranged, distributed and connected in a net-work that, with a drop or resistance of one per cent. on the mains and ten per cent. on the feeders, we are able to maintain in the system practically a perfect regulation in the distribution of the current. This system stands to-day representing one of the most complete and perfect examples of work of this class. The largest problems that we know of in underground work are the proposed new extension of the Edison company in New York, and the underground system of feeders proposed to be installed for the West End Railway, of Boston. The copper alone for the latter amounts to over $1,000,000; and this question of the cost of the copper calls my attention to a fact which I desire to notice, that much of this question of bugbear on copper is uncalled for when we are considering the underground system. The entire copper used on the system in Brooklyn is less than one-fifth of the cost of the underground system first installed.

I do not desire to claim that the ideas for the class of work here represented and described, hold or represent all the perfection to be obtained in central station work. There are many points contrary to the ideas here outlined, which are very desirable; I have merely tried to call your attention to what I consider good work in this particular line, and hope that it will result in bringing forth the discussions and additions which are very beneficial in the consideration of these problems in the results to be obtained, and I would only add a tribute to the powerful and master mind whose work, from the commencement of this field of central station distribution, has covered the leading problems and points, and whose ideas to-day represent much of the good and very little of the bad problems which we have in this work. I refer to Thomas A. Edison, whose work, commencing in this field on the old Pearl street station in New York, over eight years ago, when the majority doubted, and but few believed in its successful carrying out, and while we find that station until within the past few months, when it was partially destroyed, successfully working, and even antiquated as it was, earning large dividends. He has still continued actively to impregnate his ideas on the work from that day to this, although he has not taken such an active part in its carrying out, but I think we may see him at no distant day, again taking a hand in this work, and bringing forth many new ideas in advancing the progress of the future.

CARBON TESTS.

BY E. F. PECK.

[Abstract.]

THE first electric light of any consequence was used by Sir Humphrey Davy in 1810. He had discovered that when the two terminals of a charged electric circuit were separated a short distance, an electric spark would pass between these terminals by evaporizing the material of which the electrodes were composed, and that the vapor thus produced would continue to carry the current between the electrodes, and that these vapors, together with the highly incandescent solid ends of the electrodes would emit a powerful light. The vaporized material bridging the space between the terminals of the electric circuit he denominated the electric arc, for the reason that these vapors would pass in a curved path between the two electrodes. Sir Humphrey Davy demonstrated this interesting phenomenon by using a great variety of material for the electrodes, and he found that the most brilliant effects were produced when the electrodes were made of carbons. The carbon used by him was charcoal made from various woods. It was found, however, that the charcoal from whatever wood it was made always had a considerable electrical resistance, and was so rapidly consumed that it could not be used for the production of arc lights for practical purposes. Other electricians took hold of Sir Humphrey Davy's discovery and their efforts were directed toward the discovery of material for the production of electrodes of greater durability and better conductivity. It was finally discovered that carbon deposited in the neck of gas retorts possessed a high degree of conductivity, and was exceedingly hard, and therefore would be very durable when used as electrodes for arc lights. Rods or pencils of this gas retort carbon were made and shaped at great expense and trouble, and they were found to be excellent substitutes for the charcoal electrodes; still these gas retort carbons could never be used on a large scale for the reason that they could be shaped to the required form only at a very great expense. The next step in the improvement of carbon electrodes for arc lamps were made in 1842, when Bunsen invented what he called the "Plastic" carbon as the negative electrode of his battery. The carbon electrode was made of various mixtures of powdered charcoal, molasses, sugar, etc. It could be shaped to any desired form, and was made by Bunsen in the shape of hollow cylinders and flat plates. When it was found that this carbon electrode could be used to advantage for the production of electric arc lights, it was at once substituted for the gas carbon. This substitution was not a universal one, for as late as 1873 and 1874, Professor Tyndall was in the habit of using gas retort carbons in the production of electric arc lights, although he complained that the production of his carbon electrodes involved great expense and trouble. The carbons burned at the Centennial Exposition in 1876 were of this material, but we have no data of their life or resistance. They were made by Carré, of France, and the current was from a Gramme machine. From 1843, when Bunsen invented his "Plastic" or moulded carbon, to 1879, many inventors of this country and Europe tried to improve on his discovery. Their chief object was to produce a carbon of greater and more uniform density and higher conductivity. English patents were especially numerous during this period, and their mixtures in the more enlightened state of the art, seem now very ludicrous. Though some labored at the problem nearly fifteen years, on the whole no great improvement was made. This poverty of result was largely due to the fact that the dynamo apparatus of the day was unknown. All arc lights were produced by currents generated by batteries. The modern arc lamp, with its simple but effective mechanism, was unknown. The arc light was only a curious laboratory plaything. The proper experimental condition to enable an inventor to produce good carbons did not exist, and the financial stimulus of commercial demands was wholly absent. The modern arc light carbon of commerce is hardly ten years old. It became a necessity as soon as the modern dynamo apparatus was completed and commercial lighting by electricity was seen to be coming in the near future. The problem may be said to have been undertaken in 1878. The first point was to discover crude carbon that was both pure and cheap. At the suggestion of Fayette Brown, of Cleveland, Ohio, his son, A. E. Brown, then experimenting for the Brush Electric Co., tried residue from petroleum. Careful experiment proved this to be the long-sought-for crude material, nor have the investigations of the past ten years found any better. The next point was to manufacture carbons of the requisite quality. Nearly three years later the Brush carbon was produced. The first cost of these was very high and the demand small. Where carbons are now sold by the hundred thousand they were then sold by the dozen. Like most new articles the process of manufacture was roundabout and tedious, consequently both the cost and market price of carbons ten years ago was very high, the first carbons selling as high as $125 per 1,000. I cannot learn that any tests were made of these carbons for resistance, brilliancy or even exact life. In those days manufacturers were well satisfied if they could make carbons that would burn fairly well, and gave other considerations very little thought, because they were relatively unimportant. Besides, Mr. Brush and his associates, there were several others in different parts of the country working at carbon business on different lines. At Ansonia, Conn., the Messrs. Wallace were experimenting with forced carbons, with much success, following the process of Carrè of France. This carbon was very dense and hard, and when sounded gave forth a ring almost like a bell. Not to mention many others, Mr. Thompson, of Newark, N. J., was also in the field, but clinging to gas retort carbons for his crude material, did not meet with the success achieved by his competitors. Since those early days of experimental work, manufacturers have paid special attention to reducing the cost, lowering the resistance, and increasing the brilliancy and life of the carbon. Early in the spring of 1889, at the suggestion of a representative of one of the large carbon manufacturers, I decided to base a year's contract for carbons on the comparative test of the best known carbons in the market. I made two or three tests, taking into consideration simply the life and resistance of the carbons as adapted to the system of lighting we were using. The tests were rather crude and not made for the purpose of booming any particular carbon but to satisfy myself as to what carbon I could best afford to burn. The final test was made with a group of Thomson-Houston lamps on a six and one-half ampere circuit. Two sets of carbons of each make were placed in the lamps and each lamp adjusted to the lowest point at which a quiet arc could be maintained. A record was made of the time of starting each lamp and they were then allowed to burn until all the lamps had cut themselves out automatically, by the burning out of the carbons. The electromotive force at the terminals of each lamp was recorded at intervals of half an hour through the day. The result of the test stated briefly, was as follows :

Lamps.	1 and 2.	3 and 4.	5 and 6.	7 and 8.	9 and 10.	11 and 12.
Average. e. m. f.	42.23	42.73	47.16	48.37	47.76	49.66
Average inches burned per hour.	1.23	1.46	1.44	1.57	1.72	1.69

As will be seen by this table, there was a difference of 7.43 volts or a saving of about 15 per cent. in the e. m. f. of the best over the poorest carbon tested, and a difference in life of .49 inches per hour or a saving of 29 per cent. In a station burning a thousand arc lamps this means a saving of 64.73 e. h. p. without considering the saving in carbons. The figures given above show very plainly the importance of such tests, and I would recommend that superintendents and managers of central lighting stations give this matter their consideration before adopting any special make of carbons.

APPLICATION OF ELECTRICITY TO STREET RAILWAYS.

FRANK J. SPRAGUE.

[Abstract.]

Scarcely 15 years, said Mr. Sprague, have passed since the beginning of a new era, the transmission of energy for light, power and the reproduction of speech. Of the progress of the first and last I need not speak, for the delegates of this convention are well cognizant of their history. But that great industry, the transmission of electricity for power, with its possibilities of all kinds, is of very recent development. Six years ago there were scarcely a hundred electric motors in operation in the United States for any purpose ; to-day there are no less than 15,000 in use, applied to not less than 200 different industries; and an industrial revolution is taking place equaling, if not surpassing, in importance that attending the introduction of the steam engine.

It is not my purpose to dwell at length upon the subject of the transmission of power by electricity in its general application, but to touch upon one branch only, that of railway work, reviewing very briefly its development in the United States, pointing out the salient features of successful operation, noting what has been already accomplished, and after some remarks upon the legal questions which have arisen, considering the possibilities of the future.

The modern electric railway may be said to have been born in Europe ; its babyhood was in Europe ; but in its youth and young manhood it is purely American. In 1881, Dr. Siemens, of Berlin, established the pioneer railway on the Lichtenfeld line in the suburbs of Berlin, and I believe it is still running. It was followed by other roads, some commercial and others for exhibition, erected by the firm of Siemens, and by the work of other electrical engineers. The Siemenses also established a line at Frankfort. The Hopkinsons established one at Portrush, Ireland. Another was established at Blackpool. This last was a conduit system. A double metallic overhead system was established in 1888 at Vevay, Switzerland, and recently the Siemenses have established a conduit system at Buda Pesth.

The first line in the United States for commercial service was a suburban line of two miles, built by Mr. Daft, at Baltimore, late in 1885, using a central rail. Other lines were established by Mr. Van Depoele in various parts of the country, using the single and double trolley system, with the trolley traveling upon and carried by the wire and connected to the car by a flexible cable.

In all this pioneer work direct supply was used, but most of the mechanical features and electrical details have given way to other and more efficient methods.

Of recent work three classes demand attention : one the system of independent units operated by the storage battery, and the other two direct systems of supply, one underground, the other overhead.

There is something very attractive in the proposed application of storage batteries. To store up conveniently a large amount of energy in a box, put it aboard a car, carry it around, and take out a greater or less amount of work, offers, when practicable, a solution of the street car problem for which we are all devoutly hopeful. But, commercially, the storage battery is still a long way from being a serious competitor of the direct supply. Great improvements have been made, but they have not much altered its character or weight, or the care requisite to get an economical return of energy. These improvements have made it possible to employ heavier charges without producing buckling, have made a rougher usage of the battery possible, and have in some instances much reduced the cost of manufacture ; so that the element of maintenance is less serious than a year or two ago; but it is still necessary to have about 3,500 pounds to propel an ordinary street car. This takes up space, and is a serious extra load. It requires frequent shifting, and its capacity and discharge rate are so limited that it is impossible to work upon grades which are at all severe. I believe it is possible with care to operate a storage battery on grades not exceeding, say, four per cent., and, with limited speed and daily mileage, at an expense about equal to that of horses, or a little less ; but yet at about double the expense required upon a suitably erected and properly operated overhead system.

Nowhere in the United States, that I am aware of, is serious storage battery work being done at present. The largest attempt was on the Madison avenue line, New York city, where about a dozen cars were run for a while ; but owing to legal complications only two cars are now running there,—with what daily mileage I do not know. In the service of overhead lines motor cars start out at five or six o'clock in the morning and run until midnight. Many cars make 150 or 160 miles a day, and some cars have even even made 180 and 190 miles a day. Half of this for storage battery work is good duty, but it is not up to the demands of street railway managers, and until the radical improvements which are promised are made, its field of application will be limited.

The conduit system of direct supply has been attempted in several places, notably at Denver, Cleveland, Allegheny City and Boston, but at all these places the experiments have proved disastrous and have been abandoned, save the short section at Allegheny City. In England, the Blackpool line, under special conditions, has been, I believe, fairly successful, and at Buda Pesth, the Messrs. Siemens have a conduit system in successful operation. There, however, the drainage is perfect, and a man is detailed for given sections of the track, and is continually employed in patrolling his section and clearing it out. Assuming good sewerage, the conduit can unquestionably be made to work. It becomes then a question of cost ; but for general application, especially in view of the fact that most of our cities do not have a sewerage system which can take care of the street drainage, the expense is prohibitory save on large systems under exceptional conditions. I look forward to the time when many existing well constructed and well drained cable conduits will become electrical conduits, and electricity will then score another victory.

The system, however, which has made marked advance is the single trolley overhead system, with universally flexible underneath contact, and this has been the growth of the past two and a half years. I think I can fairly claim for the Sprague company the pioneer place in this development; but the commercial development on the lines it laid down has been pushed forward with great energy by both the Sprague and the Thomson-Houston companies. The first work of the Sprague company, other than experiments on the elevated roads of New York, was done but a short distance from this city. A single car was started in 1887 on the Union Passenger Railway Co.'s line in St. Joseph, with a small 7½ h. p. motor, single geared, and adapted to run at a very high speed on a suburban extension. That road has seen nearly every change made in the system. It has been extended twice, and has both the old style motors and the more modern equipment. But all the work done on that line was, it may be said, purely experimental, and it was not until the 2d of February, 1888, that the Richmond road was officially opened. A radical departure was made from previous work, not only in the extent of the system equipped and the number of the machines operated, but also in the disposition and control of the machines, the system of overhead wiring, and the method of getting the current from the wire. The road was about 12 miles long, with 30 curves, some of exceedingly short radius, with grades running as high as 10 per cent., and with a road-bed utterly unfit for its traffic. The equipment was for 40 cars, requiring 80 machines, and to be operated from one station. When first proposed the attempt was regarded with ridicule, not only by street railway men but by electricians. The railway men thought it impossible for a self-propelled car to ascend a grade exceeding five or six per cent.; and that a 10 per cent. grade was out of the bounds of reason. As regards the electrical problems, the motors, instead of being placed on the car body flexibly connected by chain gearing or belts to the axles, were placed underneath the car, and flexibly geared to the axles. They were uncovered and exposed to the mud and moisture, and to all the accumulations which might collect in the street. They were built to run on a 400-volt grounded circuit, and to run in either direction with fixed brushes. Insanity was a mild term to designate the mental condition of one who made these proposals. The motor man was confined to his ordinary platform and the regulating devices there situated. A wire of one-fifth of an inch in diameter was extended over the track, and supplied at intervals of its length by a wire carried alongside the street where the strain upon the poles was least, and this main conductor was supplied at three or four central points by feeders from the central station. The current, moreover, was taken from this wire, not by a traveling carriage upon the wire, flexibly connected with the car, but by an arm reaching upward and pressing underneath the wire. This contact arm, which is now technically known as the trolley pole, was placed in the centre of the car and had a universal movement, resisting up and down displacement sufficiently to make a good contact with the wire, but at the same time free to follow all vertical deflections. In addition it had a lateral movement of considerable reach, offering little opposition to any side deflections by the wire itself.

Well, Richmond has passed into history. It has had its vicissitudes, it has had its victories as well. But it remains with all its crudities and with all the accidents which have marked its career, as the one great step in advance whose features in the main, have been followed in almost all the recent electric railways. Machines have been made larger, they have been made mechanically and electrically more perfect. Changes of detail have been frequent, but most of the characteristic features there outlined mark to-day nearly every electrical railway which is either in operation, in process of construction, or under contract.

The strongest opponents of electric traction two years ago are now its best friends, and the enterprise, for which it was then difficult to get a dollar investment, to-day demands the best thought and the most active energies of two great corporations and a number of smaller ones. The friends of the cable system are on the defensive. The advocates of the electric system are reliant and aggressive. Its flexibility, the ease with which it is extended, its adaptability to various conditions of service, its freedom from long continued breakdown, the marvelous advances which have been made in perfecting its apparatus, all insure its supremacy.

As to danger, the electric car is the safest possible vehicle, because of the remarkable facility of control. Touching the objections to overhead lines on the score of danger, which have been raised by municipal authorities and cited by telephone interests, they are, we may safely say, imaginary rather than real. Almost every employé of the contracting companies and a great many employés of the railway companies, including not only the linemen, and those whose business it is to work upon the electrical equipment, but the conductors and drivers, have received shocks from the lines of greater or less duration, and under almost every possible condition. Yet in no instance which ever came under my observation, or of which we have any reliable record, has serious injury resulted from the shock of the current itself. Experience seems to be quite ample to warrant the assertion that as ordinarily constructed a constant potential circuit of 500 volts is not dangerous to human life, and we can dismiss that question.

Reviewing the work of the past two years, that which was promised for electricity has been in the main entirely fulfilled. It has proved itself capable of doing the most extraordinary work under the most unfavorable conditions. Grades of 12½ per cent., and more recently of 14 per cent., have been ascended with loaded cars. Grades three miles long, varying from four to eight per cent., have been ascended by a motor car pulling a tow car. It has done work impossible for horses. It has enabled the running speed of cars to be increased even in crowded cities 50 per cent.; and on suburban routes speeds of 20 miles or more have been made. Experimental runs of 30 miles an hour on the ordinary street car with the narrow flange wheel have been attained; and on special experiments a speed of nearly 150 miles an hour has been made for a short distance. The electric car has shown that it can run faster on both up and down grades; that it can be gotten under way and stopped more quickly than a horse car; that with any given number of cars the mileage has been increased and the same time intervals made with a less number of cars. Many cars have made from 180 to 190 miles in one day. Horse space having been saved, the equipments occupy a third less space, and this fact, coupled with the ability to back when necessary and again quickly gain headway, has enabled an electric railway car in crowded and narrow streets to work its passage where a horse car would be at a dead standstill. Not only has the possibility of running down grade faster been established, but that possibility with a high degree of safety, because in the event of losing control of a car by the brakes, the instant reversal of the motor will bring the car to a standstill. This has frequently happened, and in one case, recently reported, the inspector stated that a car was going nearly 35 miles an hour on the down grade before the driver attempted to reverse his machine; but when he did so, he brought his car to a standstill with the loss of only one gear.

It can very properly be said that there have been many breakdowns; that machines have depreciated; that there have been exasperating troubles. True, these things have happened, and in case of defective workmanship and of careless inspection or management, they will happen again no matter what system of propulsion is adopted. The accidents which can happen to a motor come within a very limited category, and the liability of a motor to these accidents is being very rapidly reduced to a minimum, till it is becoming to-day the most perfect piece of machinery, capable of the longest continued use and a large amount of abuse. The very accidents which have happened—and I may say here that nine-tenths of the troubles are due to mechanical defects—and the very makeshifts which have been resorted to to overcome troubles and keep lines in operation, are the best evidence of the flexibility of the system and the perfection to which it will arrive. No other machine in existence has in so short a period of development, been brought to such a degree of perfection, is capable of such varied application, or can be so quickly and easily understood.

In a paper read before the American Institute of Electrical Engineers in August, 1888, and in some earlier communications, I made an estimate as to the expense of operating a 30 car road, dividing these operating expenses under two heads: (1), those belonging to the central station; and (2), what may be called the road operating expenses, the sum of the two constituting the total cost of motive power. In making this estimate I used extra care, and while preserving its accuracy, made every reasonable allowance that I thought necessary. The conclusion at which I arrived in the estimate under the conditions there given, was that the total cost of motive per car mile should not exceed $4\frac{8}{10}$ cents. I also stated that this was about 40 per cent. of the cost of operating by horses, under the same conditions. My estimate was considered too liberal in favor of electricity. Without going into details, I may state that reliable records of roads, under every condition of service, bear out the claims that I then made. I have the records of only a portion of the roads which we have equipped. Some roads see fit to make public these records. Others, and with a good show of reason, do not care to do so, because of the feeling that municipal bodies, in considering the granting of franchises, will not look at the increased cost of investment, but ignoring the manifold advantages to be gained by the introduction of electricity, for the public as well as for the company, are inclined to make unreasonable demands in the way of the reduction of fares, or require unnecessary and unprofitable extensions of lines. They forget that the reduction of one cent in a fare means a cut on 20 per cent. in the receipts of the company, and that a very remarkable saving of expenses must be made in order to meet this reduction of revenue, especially where there is an increased equipment on which interest must be earned. But suffice it to say that careful investigation will convince any candid man that the economic claim has been entirely supported, and the best elements of it is in the rapid adoption of this method of propulsion.

A few remarks may be in place relating to the interferences with other established interests which this new application of electricity has developed. Such conflicts, as electricity is applied to different industries, necessarily arise and result from the claims made by two or three enterprises to the same area of occupancy, whether of air or earth. There have been, long before electric railways became at all common, conflicts between the electric lighting and telephone interests. In the early days of electric lighting, and more particularly in that branch known as constant potential distribution, an attempt was made to use the earth for one-half of the circuit, precisely as was done and has been done for years in telegraphy. Practical experience, however, demonstrated that this was a mistake where incandescent lights were concerned, and it is manifestly a mistake where arc lights and high potentials are used. The objections on the constant potential incandescent circuit were pertinent because of the liability of fire in the buildings where the ground circuit was used, and the element of personal danger very quickly put an end to an attempt to use a ground circuit for an arc light system. The same cautionary reasons applicable to these two classes of industries do not, however, apply to overhead electric railway systems. The electric railway circuit is purely an external circuit. Its derivations are through the cars which it supplies. It is led into no dwelling; its fixtures are not within ordinary reach. It is carried in the open air, in full view in the most direct possible lines, and with only such supports as are necessary to make its construction safe. The whole construction of an overhead electrical system is materially simplified, and, in my opinion, made mechanically as well as electrically far safer by the adoption of a single wire, using the rails as a return circuit. The practical proof of the wisdom of this decision is the fact that about 90 per cent. of all the electric railways in the United States, use only the single wire. It scarcely seems necessary at this stage to go into the defense of this system. Its simplicity, the lightness of construction, the symmetry of outline, the size and strength of the poles, the fewness of the supports, the simplicity of all curve work, turnouts, crossings and sidings, and especially of all switch work and switch operations, are so manifest that elaboration of these features is unnecessary.

The use of the grounded circuit has unquestionably interfered with the operation of telephones which likewise use the grounded circuit. So long as electric railways were in an experimental stage, running perhaps in suburban districts, out of the way of telephone circuits, little or no attention was paid by telephone companies to their existence. The strides which have been made in the past two years and a half, bringing the railway system into the very heart of towns and cities, and into the forefront as a commercial enterprise, and the rapid increase in the extent and use of the telephone system, have brought the two interests in direct conflict, which conflict is solely because of their common use of that great reservoir of electricity, if we choose so to term it, or rather that great common medium for conducting it which has been used alike by railways, telephones and telegraphs since these industries were started.

The claim of the telephone companies, in brief, is that by right of prior occupation and of their vested interests, no electric railway or other circuit shall use the earth if interfering with their lines in any way. Their claim is far-reaching; it is of the broadest possible character, and, strictly interpreted, is an exclusive claim on the use of the earth for transmitting energy by electricity. That there is an interference with the telephone circuits by an electric railway circuit is undeniable, and the interference is annoying. The character of the interference is twofold. Part of the trouble arises from induction, that sympathetic response in the telephone circuit to any changes in the electrical condition of the railway circuit, and part to leakage, caused by the diverting through the telephone system of a part of the current which has been discharged into the earth and is on its way back to the central station.

The relative amount of these two interferences has been variously stated. On the part of the telephone company it is admitted that conduction or leakage is a source of trouble. They also admit that the use of any metallic return circuit, it matters not what, whether it be an individual circuit for each telephone, or a common metallic return for all the telephones, will obviate this or most of it. Even this much is admitted by the telephone interests with a great deal of hesitation, despite its perfectly apparent truth. But they go further. They claim that this is not the principal cause of trouble, but that most of it is due to induction, and that if a return metallic circuit overhead were put up by the railway company—that is, if a double trolley system were used—then the telephone troubles would all cease. The various attempts they have made in the courts have been with a view to either compelling the railway companies to cease operations or to so change their system as to abolish the use of the single trolley and erect in its place the double trolley system; or, on the other hand, to compel the electric railway company to pay for the necessary changes required in the telephone circuit to avoid the interference. No sooner was this issue presented than it was promptly met by the railway interests which I represent.

Now, what are the facts? First, as I have stated, there is unquestionably an interference between the electric railway and the telephone services; but of the character of this interference it seems to me that no intelligent man who honestly makes an investigation, seeking truth, and truth only, and unbiased by the commercial interests which have retained him, can have any reasonable doubt. The assertions made by the telephone interests leave little room for exaggeration on their part. Not only has the character of the interference been misrepresented, but the costs of any changes made necessary on the part of the telephone company to avoid trouble, or on the part of the railway company to change over its system, have been grossly misstated.

As a matter of fact, the trouble from induction is of the very slightest character, and that must be patent to any one who is familiar with this particular electrical action. Generally the trolley wire is situated in the middle of the street, anywhere from 20 to 30 or 40 feet away from the telephone lines. It rarely runs parallel to them except for a comparatively short distance, possibly two, or even three miles, but more often less. The current used upon this wire is not of that character which distinguishes some of the arc light circuits, but is of more or less even flow, and the abrupt and large changes due to change of load on the motor are comparatively infrequent. There is a very small change due to the variation of resistance of the armature of the motor, because of the different relative positions of the commutator blocks under the brushes, and there is likewise a variation due to the slight but rapid changes of counter E. M. F. set up by the motor when running. But although these changes can be detected inductively, provided the conditions are favorable—for instance, if both the telephone and railway circuits were wound around a common bar of iron—the character of the disturbance is not so serious as to preclude conversation. But the trouble which does really become pronounced is that which is due to the actual difference of potential which exists on different parts of the track circuit—in other words, at the terminals of the grounded telephone circuits. There is discharged into the earth, as I have pointed out, a slightly varying current. It may be at some point considerably removed from the station and in close proximity to the ground terminal of a telephone whose exchange is likewise grounded at another point much nearer, electrically, to the station than the point of discharge. The current reaching the rail has to travel back to the station, partly by the rails and partly by the earth. Both offer more or less resistance, and there is an actual difference of potential between the point of discharge and the station, rising at times to as much as 20 or 30 volts; but it is, of course, a variable potential, and the current which flows over that path is one which varies in its character. Having discharged the current in the earth, there is absolutely no limit to its diffusion. We desire, of course, that it should return by the rails, but no boundary can be placed upon it. A part of it goes through the rails, but some portions will go through the earth, through water ways, mineral veins, gas and water connections, electric light tubes, telephone circuits, rivers and canals, and, in fact, over any and all paths which offer it opportunity to return to the source from which it originated. The shortest geographical line between two points may be a thousand feet. The paths of the current between those two points may be anything from a thousand feet to 50,000 or more. But precisely as the rail current is thus disseminated or diffused in its return paths, so also is the telephone current. True, it is only a current of small capacity, so small as to interfere with no other enterprise or translating device except others of like character, but its diffusion is of precisely the same character and over the same territory and through the same classes of conductors as that of the rail current. Could the telephone current be limited in its path, and the claim of the telephone company be narrowed down to a specific section of earth, then, possibly, there might be some basis for a claim to the use of that section; but such a restriction is, of course, manifestly impossible. Hence, any claim the telephone interest makes to the earth must be vague; it must be all-reaching; it must be exclusive. It would seem that it has no more legal right to make a claim which prohibits a railway in the town in which the telephone circuits are operated from using the earth, than it has to make a claim that a railway in any other city with which the telephone may be remotely connected, shall be prohibited likewise from using the earth in that particular city, although it may be a hundred miles off. It is a well-known fact among electricians, and probably no better known than among the telephone people themselves, that, perfectly independent of railway enterprises, a far better service can be rendered the patrons of the telephone where a complete metallic circuit is used, and the use of the earth abolished. The telephone is the most jealous detector possible of all disturbances of electrical condition on the circuit which includes it. Its very function as a transmitter of speech depends upon this marvelous delicacy. As now operated in the majority of telephone exchanges, it is subject to continual interference not only from the railway circuit but from every electric light, power or telegraph with which it is brought into proximity. It is subject to interference from atmospheric changes and discharges. The telephone circuits themselves interfere with each other. Cross talk and false signaling are common. Almost all these troubles can be avoided, and the telephone service made far more perfect by using either the individual metallic return with the switch-board properly constructed for it, or the common return, which would make absolutely no change in the telephonic switch-board—what is known as the McClure device, the use of an artificial metallic ground or common metallic return of a resistance, low compared with the resistance of the instruments. The lower the resistance of this common return the less any interference of the telephones with each other. The cost of this latter method is a bagatelle. It should be put up by the telephone companies for the sake of their patrons, irrespective of any other consideration. Wherever intelligently put up the relief from outside interference has been almost absolute, and the testimony of parties who made complaint when telephone companies first sought to obtain an injunction against the railways is now emphatic as to the relief which has been obtained by this change in the method of running the telephone circuits. It is unquestionable that the telephone company is waging the warfare from the standpoint of economy, pleading the rights of vested interests, notwithstanding every telephone expert knows the great advantage to be gained from a metallic circuit, and notwithstanding the fact that sundry papers read at the telephone conventions not only admit that the metallic circuit is best, but give testimony from the exchange superintendents that wherever their patrons once use the metallic circuit and long-distance telephone, they are never satisfied thereafter to use the grounded circuit. It is likewise suggestive that the Bell Telephone company to-day advertises about 150 local stations in New York city equipped with the long-distance telephone and the metallic circuit. Since there is not an electric railway in the City of New York, their action in this locality could not have been dictated by interference from that interest.

Since both the telephone and the railway companies occupy public streets by public license, it is of course necessary to examine into the source of their respective titles and the character of their occupancy. The electric railway has proven a great advance upon any method of street car propulsion hitherto known. It has been shown to be economical, safe and advantageous as a method of public travel. It certainly cannot be said to be objectionable *per se*. It interferes less with the travelers upon the highway than many other methods of propulsion, and its very extended adoption shows us that it has been sanctioned by public authorities as a safe and proper method of travel. The single trolley system being used by nine-tenths of the street railways in the United States using electric motive power, certainly shows that practical experience is in favor of that particular method. As an improvement upon the method of propulsion it would seem that an electric street railway uses a public highway, occupies the same and enjoys the right of travel thereon, as of equal dignity with any or all other persons or vehicles upon that highway, and that this right of enjoyment is within the original purpose for which the highways were opened. On the other hand, it is pertinent to inquire what right or title a telephone company has in the street. By virtue of the original dedication of the highway they have no rights except that of toleration. Telephones and telegraphs are identical in contemplation of law and have been held to be an additional burden upon highways. In almost every case where this question has come up in the matter of telegraphs, such has been the decision. The statutes under which telephone or telegraph lines are permitted to be erected on highways, provide that while they may be so erected, the poles and wires shall not interfere with public travel upon the highways. Since this is true, the telephone companies are upon a public road not by virtue of right, but of toleration; not as the equals of the street railway, but subordinate to it. They occupy a secondary position, and this being the case, where conflict arises between the two, it would seem that the telephone interest must eventually yield, for its claim against any competitive enterprise is nothing less than a claim to the exclusive right of the earth, not to some section of it, because there are no limits to which the telephone wires may not reach, no boundaries to the portions of the earth which form a part of their circuits. Certainly no statute gives an exclusive privilege to a telegraph or a telephone company; and any claim for such an exclusive right, to be substantiated, must show an expressed or implied grant from some source, and the boundary as well as the source of that title. Not only this, but it must show that the title is exclusive. In view of the fact that the telegraph companies had used ground circuits for 30 years or more before the telephone was discovered, and that patents were refused for such use, it will be somewhat difficult for the telephone company to show the source of its title; and it is manifestly impossible to show the limits of the territory from which any other enterprise must be excluded, so that it will in no way interfere with the operation of the telephone system, for the telephone circuits being attached to the gas and water systems of the community in which it is located, the ramifications of such systems and of all the subterranean electric conductors of the earth in contact with these metallic conductors are unknown to science. How other electric currents entering the earth may do so without invading the charmed area of the telephone and disturbing its grounded wires no man can say, much less can the telephone people themselves. The boundaries, then, of their claim being so vague, it would seem that their claim itself must necessarily fail.

Within the past two years there have been, I believe, eight attempts made by the telephone interests to get an injunction. The first was in Akron, O., in the latter part of 1888, where the Central Union Telephone Co., of Chicago, attempted to restrain one of the Sprague roads by injunction. This was denied. The next suit was against the Harrisburg road and the Sprague company by the Penn Telephone Co. A number of common stockholders, I believe, were interested in both companies, and although the attorneys of the railway companies were fully prepared and desirous of seeing the case brought to trial, the case was abandoned and compromised for the very sensible reason that it would cost less on both sides to compromise than to carry it to the higher courts. The next attempt on the part of the telephone interests was in the application for an injunction against one of our roads at Chattanooga, Tenn. This injunction was denied. Then came a conflict in Salt Lake City, where many of the people were so interested that they said as between the telephone and electric railway interests, if the decision was against the railway company they would abolish the use of the telephone. Such heroic measures apparently were unnecessary, for the injunction was twice denied. Then application for an injunction was made in Cincinnati—and this will probably become a *cause célebré*—the injunction, on what ground I do not yet know has just been granted. This case will be carried to the higher courts.

In Eau Claire, Wisconsin, an attack was made on the railway interests under cover of a state law which the telephone companies had quietly gotten passed requiring a return insulated conductor for any circuit carrying electric energy. The injunction was there denied, for the telephone company had somewhat overreached itself, and found itself quite as much in the mud as the railway company might be in the mire so far as the law was concerned, because they were themselves the carriers of electric energy and were using grounded circuits, and consequently had no standing before the court. The last case with which we have been directly concerned is one at St. Joseph, which has not yet been tried. In Albany, where another electric railway company is operating, the telephone interest has succeeded in getting a temporary injunction. I believe this case, in which my own company is not particularly interested, except sympathetically, has been recently reheard and a decision on the merits is now pending.

With the records thus given it would seem that the electric railway companies have little to fear from the attacks made upon them by the Bell Telephone company. They are well within their right, and that being so their position must sooner or later be established beyond all peradventure. Often the same stockholders have been in both companies, and a sensible compromise has been effected, in which the telephone company has sometimes changed the route of its circuits, or put up a common return, or the companies have used each other's poles, and a just division of expense has been settled upon. This would seem to me to be the better plan wherever conflicting interests arise, and is one which I would recommend in all cases where the telephone companies are willing to recognize the justice of the legal position of the railway company instead of attempting as they have in the cases mentioned, to deny that right. A just compromise, but no surrender, should be the motto of the railway company.

So much for street car practice, and looking forward we naturally ask what will be the near future of the application of this remarkable agent? Already we have gone from one car units to trains of 2, 3 and even 4 cars in the street, and 40 cars have been operated from a single station. The next step will be the operation of some of the cable roads, then systems like the Underground Railway of London, the Elevated railways of New York, the Brooklyn Bridge system, and then suburban lines will be operated. But is this the limit?

I have been frequently asked whether, in my opinion, electricity will ever be used on trunk lines for through passenger or freight traffic? My answer is: Probably not, according to present notions of trunk line transportation, and not by present methods of train despatching. But with these qualifications I admit my hope and expectation of rapid transit under certain conditions. Let us for a moment consider a few facts.

Railway managers are constantly meeting with a demand for more rapid and luxurious methods of transit, and every effort which executive ability and financial expenditure within reason can devise is made to meet this demand. I think I can safely say that as steam railways are operated, a maximum speed of ninety miles per hour, and a running speed of sixty to seventy is all that can be hoped for in steam railway travel under the best conditions which can be provided. The limitations are too many. The maximum speed of a locomotive to-day is little more than it was twenty years ago. True, engines are larger and more powerful, but the increased weight of trains has made this necessary. To get pulling power there is a limit to the size of the drivers, and whatever their size there is a limit to the economical rate of piston speed and to the number of revolutions per minute. As the size of the driver increases, the centre of gravity of the engine is raised. As the steam demands become greater the difficulty of taking water and of firing grows more pronounced. Even now it requires the best work of a fireman, when his engine is pulling heavy load, to prevent the engine dying on the road, or at least falling far short of its duty. The increase of running speed has been obtained principally by cutting down grades, straightening curves, filling up ravines, replacing wooden structures by permanent way of iron or stone, the use of heavier rails, safer switches, improved methods of signaling, the interlocking switch and signal system, road crossing gates, the abolishing of grade crossings; in short, by improvements in detail and management which permit a higher safe speed over a more extended section of road, because of greater intrinsic safety, and of the greater degree of confidence inspired in engine driver, rather than by marked advance in the speed capacity, which should not be confounded with the pulling capacity of the engine *per se*.

With respect to electric motors, the question is not now whether a motor of sufficient capacity can be built, or efficiently and positively controlled, but rather how can the electricity be produced and supplied to the motor and at what potential can we work? We all hope to see the time when electricity can be produced economically from coal without the intervention of engines or dynamos; but I think that even then it will be quite likely that a central method of distribution will be the more advantageous. On the other hand, there are those who hope to see the storage battery so reduced in weight and improved in other particulars as to warrant its use in a large way in locomotives. For myself, I prefer to consider the possibilities of another method, the amplification and development to its full capacity of the present street railway practice, and for that purpose I will briefly consider a supposititious case, namely an express between New York, or rather Jersey City, and Philadelphia. The highest demands of such a service would require that, independently of the local travel, a through express track should be constructed by the most direct route possible between the principal localities, and every effort made to reduce the curvature and grades as much as possible. No matter how much it costs to build such a road, when the traffic is sufficiently large, it will pay to do it.

Suppose such a road to be an electrical one, and the method of supply to be from one or more central stations, the current being taken by a universally flexible underneath contact from a rod run above the car, and the return circuit made by means of the rails. What concerns us, as electrical engineers, is whether the cost of copper, the potential required, the losses on the line and the number of stations are such as would be prohibitory.

As regards the potential, other things being satisfactory, whatever pressure is demanded in the interest of economical and effective service will be used, and means will be found, consisting mainly in cars of construction, which will make its use for the purposes, and, as intended, safe and proper. We have, in these matters, to face the same questions that we have in the matter of steam pressure, or of railway speed. To accomplish the larger engineering feats necessary to meet the demands of economy and commerce; we will be governed more by belief in our power fully to subordinate a good servant to our will than by our fears of its vagaries.

From 8 A. M. to 9 P. M., a period of 13 hours, 21 regular trains leave the Jersey City station of the Pennsylvania road to run through to Philadelphia. Twelve of these make but one or two stops. The others make more or less stops according to the running schedule. Taking the through trains only, and allowing an average of say five cars to a train, there are in the 13 hours about 105 through cars despatched from Jersey City, or at the rate of one car every 7½ minutes, and of the through cars not making over one or two stops there would be one every 13 minutes. We will suppose an additional express track built, leaving the distance about what it is now, say 90 miles, but that the grades have been eased and the worst curves rectified. For the practical purposes of this paper I will consider that the road is level, that the cars are to be despatched in two-car units on a perfect block system, and to run through to Philadelphia with not more than one stop, at fixed intervals, and at a high average rate of speed, say sixty miles per hour. In the system I would propose—practically that with which I experimented some years ago—slight grades would make little difference in the general result, especially if the grade percentage, expressed as a whole number, does not exceed the quotient of the traction in pounds per ton divided by 20; because when $c = \frac{t}{20}$, where t equals traction in pounds per net ton, and c equals grade percentage expressed as a whole number, the work of traction and of lifting are equal. For example, suppose $t = 10$ pounds and $c = \cdot\frac{1}{2}$ per cent., and that we had on a double track one unit coming down the grade and the other ascending it, both at the same speed. Then gravity would be supplying just enough power to propel the car on the down grade at a fixed speed, and enough power to supply the lifting and traction work of the other car would have to be supplied, which would be just the amount required to propel both cars on a dead level.

Suppose the grade to exceed the ratio expressed above, then the car on the down grade would have an excess of falling energy, and this would be used in accelerating the speed of the car, or on the brakes, or it could be used by a process of reconversion for the purpose of supplying at short range part of the extra energy required by the ascending train. Just how this can be done is pretty fairly understood by electricians, but I will touch upon it again, because it is a feature of vital importance in determining the matter of motor control in a large system such as we are now considering, and because it illustrates one of the most beautiful features of this method of converting energy. No matter whether a machine be used for a motor or a dynamo, whether to convert mechanical energy into electricity or the reverse, the armature develops an electric pressure of potential which is dependent upon its speed and the effective strength of the magnetic field in which it is used. If this field is in shunt relation to the armature and in connection with the track circuit, we have by any of the well-known methods a means for independently varying the strength of that field. When such a machine is geared to a car, it can either drive the car, acting as a motor, or be driven by it as a dynamo, and in connection with any other similarly connected motor, or the central station generators, will form an electrical couple, either of which may be driven by, or drive, the apparatus to which it is connected. If the couple thus established is between the motor and the central station dynamo we have at one end a machine driven by a constant speed engine and generating an approximately constant electromotive force, and at the other end a machine of greatly varying speed, and with facility for increasing or diminishing the electromotive force which it generates. The result is an electrical differential which will establish a current between the two in one direction or the other, according as the pressure developed by the motor is lower or greater than that developed at the generating station. If the pressures are equal no current will flow between them. If the couple consists of two motors thus connected, then we have two apparatus, each of which is generating a variable electromotive force, and there will be a current between these or not according to their relative electrical pressures.* A large system is tied together in the most intimate manner possible. The tracks are cross-connected, the overhead conductors cross-connected, and we would have, in effect, what would correspond to two large planes, between which is moved at varying speeds a number of independent units these two planes being kept at a fairly constant potential by means of the generating station. All motors starting, running on a level, or ascending a grade, would be requiring current. All motors running on a down grade with just that velocity which the force of gravity would give them would require no current; and motors running on down grades of greater percentage than is required to give them power for traction, or motors slowing down, would be generating currents to aid in the general supply. No other system of distribution can by any possibility have this very remarkable interchange of energy. When running at a particular speed a slight movement of a regulating handle would make the motor receive from or give to the line currents in any desired quantity. The braking power of a motor thus acting as a generator is very powerful and the most perfect imaginable, because, unlike the ordinary methods, the brake does not operate if the wheels stand still, the very essential of the braking operation requiring the wheels to turn. It is a well-known fact that the most effective brake work is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and contrary to the ordinary braking practice, the energy of the electric train instead of being thrown away, in the form of heat and using up the wheels and brakeshoes, can be made useful in the propulsion of other trains. I have tried this method of braking with such a degree of refinement that a heavily loaded car would creep on a down grade at a pace so slow that an egg could be put under the wheels and cracked and removed before the wheel would pass over it.

Having thus touched upon the characteristics such as I would propose for a railway system of this character, let us resume the consideration of the proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume, for the purpose of this investigation, an overhead conductor in the form of a solid rod one inch in diameter over each track, or, if you please, a smaller rod over each track, and a main conductor making up on equal weight, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations and because it falls well within the limit of expenditure which such a system would warrant. For instance, the American Bell Telephone Co. has a line of long-distance telephone wires running from New York to Boston, a distance of about 300 miles, nearly three and a half times the distance which we are considering. On these poles are about seventy wires, each of No. 12 copper. The aggregate area of these conductors is over 300,000 circular mils, and the total weight of copper on this line, which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking.

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia, 12 usually make only one or two stops. Allowing 60 cars, this would be about one car every 13 minutes. This interval of 13 minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary to run these cars in double car units. We will assume for our purposes the size of a car such as is used on the elevated road in New York or the Brooklyn Bridge, which would, with motor and passengers, weigh from 20 to 25 tons, or a total of say 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is :—

$$c\,m = \frac{15,666\;n\,l}{E\,v\,\varphi};$$

where n = the number of horse-power, l = the distance in feet, E the potential at the motor, v the fall in potential and φ the commercial efficiency of the motor. If we assume the station situated in the middle of a line, that is, at the best point, and the work divided equally at the middle section on each side, then l being the length of line, we have the formula :—

$$c\,m = \frac{15,666\;n\,l}{4\,E\,v\,\varphi}.$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used, then the formula will become

$$c\,m = \frac{15,666\;n\,l}{4\,E\,v\,\varphi\,S^2};$$

that is, the size of the conductor would vary inversely as the square of the number of stations, if properly distributed. v may be expressed as a fraction of E, and for practical purposes we will let $v = \frac{1}{9}$ of E, and φ such that

$$\frac{15,666}{\varphi} = 16,800;$$

that is, φ = about 93 per cent. Then we have

$$c\,m = \frac{37,800\;n\,l}{E^2\,S^2}$$

which may be expressed thus, that the size of the wire varies inversely as the square of the product of the number of stations and the electromotive force.

We may also note that with any fixed size of conductor the electromotive force and the number of stations vary inversely—a somewhat important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$h\,p = \frac{4}{75}\,w\,m\left(c + \frac{t}{20}\right)$$

where w = the weight in net tons ; m, the miles per hour ; c, the percentage of grade expressed as a whole number, and t, the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10 lbs. per ton as our average traction,

$$h\,p = \frac{2}{75}\,w\,m;$$

which, substituted for n in the distribution formula, gives us

$$c\,m = \frac{1008\;w\,m\,l}{E^2\,S^2};$$

or substituting for l, 5,280 d, d being the number of miles between stations,

$$c\,m = \frac{5,322,240\;w\,m\,l}{E^2\,S^2};$$

we have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence, substituting for $c.\ m.$, its value, 2,000,000 we have

$$E = \frac{2.66112\;w\,m\,d}{S^2},$$

or,

$$E = \frac{1.631}{S}\sqrt{w\,m\,d}.$$

It will be noted that m, w, and d, that is, number of miles per hour, weight handled, and distance over which operated, are all affected in the same way. Hence with any value of E and S we can vary the relative values of w, m, and d, so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For w, the total weight, we can substitute the weight of each unit, c, and the number of units, b, thus making the formula—

$$E = \frac{1.631}{S}\sqrt{m\,b\,c\,d}.$$

For the line proposed, $d = 90$, and we have

$$E = \frac{15.56}{S}\sqrt{m\,b\,c}.$$

Taking our unit of two cars at 50 tons, the time intervals between them at 10 minutes, and 60 miles per hour as the mean speed, we have on the whole system 18 active units of two cars each, and $m\,b\,c = 54,000$, which substituted in our formula gives

$$E = \frac{3,615}{S},$$

which means that with one station in the middle the potential at the most or farthest from the station would be 3,616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time, but perhaps not yet. Nor is there any necessity for doing so ; for if we increase the number of stations and go to a three-wire, instead of a two-wire system, making the track the balance of circuit, we would have the motor potential as expressed by the following table :—

Stations.		Motor Potential.	
Number.	Miles apart.	2-wire.	3-wire.
1	...	3516	1808
2	45	1808	904
3	30	1205	603
4	22½	904	452

which last brings us down to ordinary street car practice, which is only the beginning of what will be done in the effective handling of potentials.

So, after all, it does not seem such a serious electrical problem, and certainly not one to shrink from.

We can in another way illustrate the influence of the position and number of stations and the potential used. Suppose we had a station at Jersey City to supply the entire line at a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one-quarter. Use two stations properly spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the three-wire system and the weight is again quartered. So that by these very simple processes the original weight has been reduced to $\frac{1}{256}$th of the original.

I don't think I need to point out further the use of a proper determination of electrical values in a problem of this character.

We see then that the supposititious case is well within the range of possibilities. A 60-mile express service every 10 minutes instead of a 40 to 45 mile service every hour would revolutionize travel. Of the comforts of such a system I need not speak. That it will in the not very distant future be a fact, I know you all agree with me in hoping.

POINTERS.

.... VERY few of our countrymen realize that from one brief clause in the Constitution, guaranteeing protection to inventors for their inventions, more than all else, has resulted our great national advancement.—*Charles J. Kintner.*

.... STATEMENTS denying the possibility of results of great importance are useful as incentives to those in the same line who do not agree with their authors.—*Elmer A. Sperry.*

.... A CONSCIENTIOUS superintendent of an electric light central station should make it his business to see each splice made and finished.—*C. F. Dunderdale.*

.... THE discoverer of a truth is not he who guesses, though he may guess aright, but he who practically demonstrates a new fact, and thus compels its acceptance within the body of knowledge.—*Foree Bain*

... THAT is the best engineering, not which makes the most splendid or even the most perfect work, but that which makes a work that answers the purpose well at the least cost.—*Ashbel Welch.*

HOW TO MAKE ARC LIGHT CIRCUITS SAFE.

BY J. E. LOCKWOOD.

[Abstract.]

I DO not mean to convey the idea that arc light circuits are not, and will not always be dangerous, under certain circumstances, but I mean that with our present knowledge we can make our arc circuits so safe to our employés and the general public, that accidents will be of such rare occurrence as to attract no adverse criticism from either the press or the people.

We all know that the past year has been productive of more harm to electrical interests than any other year since we started, and there is no gainsaying the fact that the accidents have been in nearly all cases from arc light circuits, such as are usually termed "high tension circuits." Let us then benefit by the lesson we have had, and from this time forth see that nothing is left undone to prevent a recurrence.

Now the first thing to do is to locate the causes of dangers and troubles, and then to show a way to avoid them. As to the cause, we all know that the prime cause in almost every instance is a grounded circuit, and though there are other things to guard against, I think that if we can effectually guard against grounds, or be sure that the instant a ground appears, that fact will be known, and the ground located so that it can be quickly removed, the other causes will not be likely to result in much trouble. Now, to avoid the dangers resulting from grounds, we must first provide some means to enable us to know where "a ground" comes onto a circuit. It has been suggested to make a permanent ground in each circuit through a high resistance with an annunciator drop in circuit, so that when a second ground occurs a portion of the current will be shunted through the high resistance and drop and thus cause the drop to fall and indicate the coming on of the ground. An apt suggestion in regard to trying these devices has been made, viz.: that before asking others to try it, the inventor should be first connected to a high tension arc circuit and then make the second ground through his body. If this suggestion is carried out, I do not think this particular inventor will bother us any more.

Many other ideas have been advanced and tried to accomplish this result, but to-day I know of but one system that will indicate automatically a ground the instant it appears on a circuit, and that of itself creates no danger. This is the Rudd ground alarm, the invention of Mr. C. H. Rudd, of the Western Electric Co. of Chicago, and it is in use at the station of the Chicago Arc Light & Power Co., and I believe at a few other places. The Rudd system is as follows, the description and cut being taken from the *Western Electrician* of August 24, 1889.

[Mr. Lockwood here described the Rudd ground detector, which consists in the use of two condensers, a relay and a local bell circuit; one side of each condenser being connected to the + and — terminal, respectively, of the dynamo, the other sides of the condenser being connected together and to ground through a relay (usually an annunciator drop) which when actuated closes a battery circuit through a vibrating bell.] This device does not ground the circuit, but acts from the static effect due to a disturbance in the insulation of the circuit.

If this system is used a ground will be indicated the instant it appears, and we then have before us the problem of locating it. If, however, the above system is not adopted, the next best thing to do is to test every circuit regularly each day at certain specified hours, and I should advise a test every two or three hours while the circuit is in operation and two tests while not, the last two to be made, one the first thing in the morning, the other just at a sufficient time before starting up to give time to remove the ground if one is found to exist. If any circuits are operated all the time or nearly so, all four tests should be made while in operation at regular intervals.

I believe that the majority of grounds occur while circuits are in operation and that the best time to test for the same is at this time. In most cities there are many circuits that never have all their loops thrown on except when the circuits are in operation, and therefore this is the only time when the circuits can be tested in their entirety. To make these tests would require appliances to test circuits in operation and circuits not in operation. For the "dead" circuits, I would advise any of the testing sets now made by electrical instrument manufacturers, which are a combination of rheostat and galvanometer on the Wheatstone bridge principle, and which will test satisfactorily up to at least one megohm. A brass plate at the switch-board should then be provided and the same connected well with the earth. Now, by connecting one wire from your testing set to this ground plate and the other to a terminal of a circuit, your circuit and the earth become portions of the circuit and the ground connection between those two can then be measured. The total resistance less the resistance of the portion of the circuit between the set and the ground will be the resistance of the ground connection. No connection of less resistance than 100,000 ohms should ever be allowed to exist, and preferably not less than one megohm.

We now come to the locating of grounds when they are found to exist, and we will first take up grounds on dead circuits. To carry out this work we need the combined galvanometer and rheostat already spoken of, and the principle upon which the same should be applied is to divide yonr circuit into two parts by means of a cut-out box provided for this purpose, or other convenient means, and then to find upon which of these two parts the ground exists. After having determined this we can then connect the two parts of the circuit together and test next from a point about midway in the part upon which the ground exists, first separating the portion of the circuit leading to where the first test was made from that portion leading beyond this point; if the ground is still beyond this point, we must close the circuit here and again open it farther on and thus finally locate the ground. But if the ground is located on the portion of the circuit leading to where the first test was made we then know the ground to be between that point and the point where we are now testing. We can thus by dividing and subdividing the circuit locate the exact portion upon which the ground exists. As an adjunct to the foregoing, and as a convenient means of cutting the current off from a portion of the circuit without affecting the whole, as is sometimes necessary on account of a fire, it is advisable to divide each circuit up into four or more sections and to provide cut-out boxes so that any one or more of these sections can be cut entirely out of circuit.

In testing for grounds each section could then be tested separately and thus locate that upon which the ground exists, so that if necessary all of the circuit but the grounded section could be started up and then as soon as the ground is removed this section could be cut in.

In addition to providing these cut-out boxes loop circuits only should be put up, their advantages being too well known to need any explanation.

We now come to the locating of grounds upon live circuits. In Mr. Law's method the principle is that high voltages can be easily tested with ordinary appliances, such as incandescent lamps and ordinary voltmeters, if we test by steps. To do which, as many incandescent lamps of as nearly as possible a uniform resistance should be connected in series as there are arc lamps on the longest circuit to be tested. If, then, this series of incandescent lamps be connected across the terminal of the dynamo or circuit where the greatest difference of potential exists, as the incandescent lamps are connected in series and as there are as many as there are arc lamps on the circuit, each incandescent lamp will get the same number of volts as each arc lamp. Mr. Law states that he prefers using incandescent lamps of as nearly as possible the same voltage as his arc lamps, say of from 45 to 50 volts, so that when they burn at their normal candle power he will know that they are each getting the same number of volts as his arc lamps average. Now, before going farther, I wish to explain that as the current leaves the positive terminal of the dynamo, it is at its maximum voltage, which we will call 3,000 volts, and that as it passes through each arc lamp and is lowered at an average of about 50 volts per lamp, we have only to find the voltage of the current at the point of the circuit where the ground exists and then to divide the difference between the maximum voltage and the voltage at this point by the average voltage per arc lamp to find how many lamps are between the ground and the end of the circuit at which the test is being made. If, then, we have a list of the lights on this circuit arranged in the order in which they are connected, and stating which is the positive and which the negative end of the circuit we have only then to count off the lights and thus locate the ground.

This is substantially what is done by Mr. Law, with the simple difference that as he has means for cutting down the number of incandescent lamps in the series, he therefore connects one end of the series to a ground plate and the other to one end of a circuit, and if there is any indication of a ground, he then cuts down the number of incandescent lamps in the series until those left in the circuit burn at their normal candle power. A number of these then correspond to the number of arc lights between the end of the circuit from which the test is being made and the ground. For proof the test is repeated from the other end of the circuit.

My objection to this system of testing is based upon two reasons, first, because low voltage incandescent lamps are used that take about one and one-fourth amperes to bring up to normal candle power, and thus create a danger by the liability of this amount of current when passing through a light ground to cause fire, and the possibility of accident to persons who may come in contact with the circuit, being tested at a point far enough removed from the end at which the test is being made to cause serious results. What we want is to remove all the danger we can, not add new ones.

My second objection is based upon the very point wherein Mr. Law finds his system does not work satisfactorily, viz., that his system is not suitable to locate a weak or high resistance ground.

Now we should at least be able to test up to 100,000 ohms, and as with a voltage of 3,000 we could only get a current through this high resistance equal to 3,000, divided by 100,000, we could thus only get three one-hundredths of one ampere, and we could consequently use a system that could be operated by this amount of current. Now, to make our ground the least factor in the test, and as we would have only about one-half our incandescent lamps or high resistance coils in circuit in most tests, we must use resistance coils, and make them of such a resistance that 30 will equal at least one megohm, and thus each one would be about 33,000 ohms. As this high resistance is necessary to apply this system satisfactorily, you can all see plainly why I do not approve of the incandescent lamp system. If, however, incandescent lamps are used for ground testings only, those of the highest possible resistance and that use the smallest fraction of an ampere are suitable, and of all the styles now on the market the eight-candle power 110-volt lamp is the most suitable, because if, as many of these lamps are used as there are arc lamps in circuit, they will each only get about 50 volts, and consequently about one-tenth of one ampere, and will thus enable us to test up to a certain resistance equal to the maximum voltage of our circuit, say 3,000 volts, divided by the amperage, one-tenth of an ampere, which would be 30,000 ohms, a great increase in range from the low resistance lamps, which only enabled us to test up to 2,400 ohms. If lamps are used we should also use a dead-beat volt-meter, such as made by the Weston Electrical Instrument Co., and it should be connected in shunt around the first lamp of the series, which should be of enough higher resistance than the rest of the series to make it a resistance when connected in multiple with the volt-meter, just equal to that of each of the other lamps of the series. We could then, when making our test, cut out of circuit the incandescent lamps until the volt-meter indicated as nearly as possible the voltage which our arc lamps average. The number of incandescent lamps still remaining in circuit would then correspond to the number of arc lamps between the end of the circuit being tested and the ground. I would much prefer thus using a volt-meter and high resistance lamps to using low resistance lamps and bringing them up to normal candle power. This outfit could also be used, to find the average voltage of arc lamps on any circuit, and having once determined this point, and also how many lamps the line is equal to, and then test and find out at any moment how many lamps are being used on any circuit, and, if we are running a number of circuits from one dynamo, we could then find how many lamps are burning on each circuit, and plan our changes and combinations understandingly. A great improvement on this system would be a volt-meter to read up to five or six thousand volts, such as Mr. Law says can be made by the Weston Electrical Instrument Co., and the amount of the improvement would depend entirely upon the fraction of an ampere used to operate this instrument. The smaller the fraction the greater the improvement. With such an instrument the coming on suddenly of a ground when a test is being made, even if at the opposite extreme of the circuit, would do no harm to the instrument. This instrument should be as nearly as possible dead beat, so that in testing for a swinging ground the instrument would indicate accurately the voltage at the ground, even if the connection only existed for a moment. We now come to a system of testing which I think a great improvement over those already mentioned, except in one particular, viz.: the testing for swinging grounds. For this purpose the extremely high resistance and high capacity, dead beat volt-meter I consider better than anything else. This new system I had the fond belief up to a few days ago was original with myself, but I find the old saying, that "there is nothing new under the sun," has been again exemplified by my finding that practically the same system is in use at the stations of the Arc Light & Power Co. in Chicago, it having been put in, I understand, by Mr. Rudd of the Western Electric Co. of that city. The system in brief, is similar to the Wheatstone bridge, as the principal is to form a shunt circuit between the terminals of the arc circuit by means of from sixty to 100 coils of high resistance connected in series, and then by means of any very high resistance galvanometer finding the point on the shunt circuit from which no current will flow to grounds, then by noting at what point on the shunt or testing circuit for which this neutral point is the ground, it can easily be located. In applying this system I would provide means for cutting out of circuit any number of these coils with the idea of using at each test only as many coils as there are arc lamps burning on the circuit at the time of the test. Then when the neutral point is found you can see at once, without figuring, between what lamps on your circuit the ground exists. The advantages of this system are: First, it creates no new dangers; second, the question of how high a resistance ground can be tested depends simply upon the sensitiveness of the galvanometer; third, it is quick and accurate, and cannot be damaged by grounds suddenly coming on when testing. Now as a necessary adjunct to any of these systems of testing, there should be prepared a list of the lights and service on each circuit arranged in the order in which they are connected in the circuit, and stating which is the positive and which the negative end of the circuit. With such lists a competent lineman, when notified that there is a ground so many lamps distant from the negative or positive end, as it may be, of a certain circuit, should have no difficulty in quickly locating it, and to enable him safely and quickly to do this, he should be provided with a high reading volt-meter, so that by going directly to the point where he thinks the ground exists and testing from the circuit of the ground with his volt-meter he could tell whether the ground was very near or not, and if not about how many lamps were between this point and the ground. Then by testing again a little further on he would immediately see whether he was approaching or leaving the ground and thus could quickly locate same. In conclusion, I would say that I firmly believe that if we use such a system of testing and equip our circuits with good lightning arresters, and some such device as the circuit openers lately brought out to disconnect the dynamo from the circuit when the current ceases for an instant through the breakage of a wire or any other cause, and then see that our employés use these appliances and do their utmost to keep all lines clear of grounds, we will have few accidents, and the press will have little or nothing more to say about the dangers of electricity.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Resumption of Arc Lighting.—Overhead Lines Improved.—The New Interior Conduit.—Electric Search Lights on Sound Steamers.—Electric Lighting in the Metropolitan Museum of Art.—The New York Telegraph Club Seeking New Quarters.—Another Subway Explosion.

THE subsidence of newspaper clamor regarding the overhead wires has been followed by the resumption of arc lighting in all parts of the city. The lines have been put into an improved condition, but are not yet up to the standards prescribed by expert Wheeler, who does not care to assume the responsibility of accident by certifying them. Affairs are now moving along smoothly, although an accident might create another sensation. There was a slight fire at the entrance of some wires into the Pearl street Edison station a few days ago, but the item was placed in obscure position in a Sunday paper, and its demoralizing effect was not so perceptible as it would have been had it appeared on the first page with a display head.

The new "conduit" for interior wiring, which has just been brought out by Mr. E. H. Johnson, for general use with any system of distribution, seems to be a good safeguard against fire from inside conductors. Several severe but satisfactory tests of its fire and waterproof qualities have been made.

The recent disaster to the steamer *City of Worcester*, which ran on Bartlett's Reef, New London, during a dense fog, has led to the introduction of electric search lights on the steamers of the Stonington line, the first boat equipped being the Rhode Island.

Considerable difficulty has been experienced by the executive committee of the Metropolitan Museum of art, in determining the best arrangement of the incandescent lamps with which the entire building is to be lighted. Various methods were proposed by different members of the committee, and finally the wire men were given instructions to fit up different rooms according to the various plans suggested, after which the full committee made its choice. The work was rapidly pushed, and the museum will soon be thrown open Tuesday and Friday nights.

Judgment for $101,484 was docketed January 28th in the County Clerk's office against the Bentley-Knight Electric Railway Co. It is in favor of the Thomson-Houston Electric Co., and was obtained in Supreme Court last year on four notes of $25,000 each made by the defendant.

The New York Telegraph Club's rooms, corner of Fulton and Church streets, have been set on fire twice, and some very valuable relics destroyed which cannot be replaced. An effort has been made to secure suitable rooms elsewhere down-town, but without success so far.

Another subway explosion occurred on Sunday, January 26th, in the vicinity of Broadway and Forty-second street. No damage was done, but it is significant that these explosions occur with such frequency that an accident insurance company is now using an illustrated cut in which a flying man-hole cover, a column of smoke, and a demoralized pedestrian are conspicuous; the moral, of course, being that notwithstanding the wires are likely to be buried, danger still lurks in the highway.

NEW YORK, February 25, 1890.

PHILADELPHIA.

The Muddled State of Philadelphia Legislation on Electrical Wires.—Electric Heating.—Electric Lighting in Germantown.

DESPITE the fact that council's negligence killed a good bill in 1887 designed to bury beneath ground electric wires, enough law was enacted previous to that time to mitigate greatly the situation. In fact, the law was clearly designed to do away with overhead wires.

On the 22d of March, 1880, an ordinance was passed conferring upon indviduals and corporations the right to lay underground conduits as receptacles for telephone, telegraph and electric wires. Then the matter slumbered for two years. On June 18, 1882, an ordinance was passed which read as follows :—

> "Prior to the first day of January, 1885, all poles and wires erected for telegraph, telephone and electric light purposes by firms, corporations or persons other than the city of Philadelphia shall be removed from the streets of the city of Philadelphia.
>
> "It shall be unlawful after the above date to erect or maintain any poles for the above-mentioned purposes in the streets of the said city excepting as provided for in foregoing sections so far as the same relates to the city of Philadelphia.
>
> "Any corporation, person or persons, excepting the city of Philadelphia, erecting and maintaining any poles and wires for the above purposes in violation of the provisions of this ordinance shall forfeit and pay fifty dollars for each day each of said poles is maintained, to be recovered as like penalties are now recoverable by law."

The date of the enforcement rolled around, but it is still a dead letter, despite the fact that in 1884 city solicitor Warwick, in an opinion delivered upon the ordinance, stated that no legal obstacle to its enforcement existed. This state of affairs shows that there exists a lack of executive as well as legislative interest.

By virtue of an ordinance passed February 16, 1886, the chief of the electrical bureau is authorized to issue permits for the erection of such electric light poles and wires as may be required for the lighting of public streets. Providing, and mark well the provision, "that none of the poles so erected shall be used for supplying light for private purposes."

A very interesting exhibit was made in the exhibition room of the Master Builders' Exchange a few days ago. It attracted a great deal of attention. It is an electric car-heating apparatus, electrical cooking stove and an electrical boiler attachment. The cooking stove resembles an ordinary skillet on an iron frame work, with a tin cover which will retain the heat and odor.

Anything can be cooked on this appliance that can be cooked in an ordinary range. The heat is intense, and the stove no more trouble than a common incandescent lamp. The car heater looks like a waffle iron 6 x 24, and is expected to throw out sufficient heat to keep a standard size railroad coach comfortably warm. A very small dynamo will suffice to heat an entire train of cars

The Electric Light Co., of Germantown, which is erecting a large building for its plant at Armat and Cumberland streets, expects to have everything completed for the running of machinery by March 1st.

In a recent letter the poor quality of gas with which this city is supplied was mentioned. Here is the way a well-known hotel proprietor jokes about it. He has obstinately refused all overtures of an electric light company to illuminate his place, and his plea is that there is absolutely no danger in using the gas that is now served in this city. "Even danger of asphyxiation is avoided," he says. "A fellow locked himself in one of my rooms the other day and turned on the gas with the intention of taking his life, but imagine his surprise the next morning when he was awakened by the pangs of a fierce appetite. Why that gas is absolutely wholesome."

PHILADELPHIA, February 19, 1890.

BOSTON.

The Brush-Swan Co.'s Victory.—Number of Public Arc Lights in Boston.—Meter Service Demanded in Chelsea.—The Public Lighting Controversy; the Aldermen Refuse Pole Privileges to the Suburban Light and Power Co.; an Appeal to the Courts by that Company.—The West End Electric Road.—The Gas and Electric Light Commissioners' Report.—Electric Search Lights on Sound Steamers.—An Experimental Port-Electric Plant.—A Paper by Mr. F. M. Gilley, on the "Electrical Treatment of Sewage" at the Society of Arts.

THE Brush-Swan Electric Light Co., of New England, said to be owned by the Westinghouse people, having defeated the Brush Electric Co., in a suit for the specific performance of contracts, have thereby forced the Brush company to relinquish all its business in New England.

From the annual report of the superintendent of lamps, it appears that there were in use in Boston on Dec. 15, 1882, 214 electric lights; Dec. 15, 1883, 381; Dec. 15, 1884, 401; Dec. 15, 1885, 446; Dec. 15, 1886, 501; Dec. 15, 1887, 577; Dec. 15, 1888, 704; Dec. 1889, 798. The distribution of the 94 lights which have been added during the past year has been as follows: City proper, 32; South Boston, 11; Roxbury, 15; Charlestown, 6; East Boston, 5; Dorchester, 15; Brighton, 10; total 94. The number of 798 electric lamps forms but a small part of the 13,810 public street lamps, yet the cost of comparative maintenance is as follows: 1888—Paid for gas and oil lighting and care of same $374,828, paid for 704 electric lights $151,413; 1889—Paid for gas and oil, lighting and care of same $363,931, paid for 790 electric lights $180,895.

On the 27th of January the state gas commissioners gave a hearing at the city hall in Chelsea, on the petition of Joseph B. Everdean and others that the Chelsea Gas Light Co. be compelled to furnish incandescent electric lights to its customers by meter. Mayor Champlin and Frank M. Gilley appeared for the petitioners, and William G. Peck represented the Gas Light company. Mayor Champlin, in his opening, said the petitioners were some of the best business men of the city, and charged that the Gas Light company discriminated, in some places charging 25 cents per month for lights, and in other places $1.25 per month. Mr. Peck, for the company, stated that if a true meter could be found the company would readily adopt it.

The aldermen of Boston have finally disposed of the question of admitting the Suburban Light and Power Co. to do business in the city. The committee of the whole board held two lengthy sessions February 10; and at the meeting of the board later on the same day, the result of the committee's deliberations was made known. Two reports were made by the committee.

The majority report, recommended that the minority report of the committee on electric wires, made Jan. 27, be accepted. The minority report of Jan. 27 recommended "leave to withdraw." It called attention to the remonstrances which had been filed by a large number of business men against increasing the number of electric light wires in this city, and said that the board of fire commissioners, the board of fire underwriters and insurance men generally were opposed to the proposed increase. The minority report (committee of the whole, February 10) which was submitted, stated that by the opinion of the corporation counsel "the Suburban Light and Power Co. can legally contract and furnish electric lighting in the City of Boston, as it may obtain locations for from the board of aldermen." The minority reviews the circumstances of the award of the contract to the Suburban company by the superintendent of lamps, and says that "if there was no other reason for granting the petitioner's prayer, good faith and fair dealing with individuals demand that the bid accepted by the superintendent of lamps be ratified by any action which is necessary on the part of this board, but the more so, in this case, since the citizens in the particular districts to be affected are practically unanimous in favor of such action." The minority recommended the passage of the order granting the locations, with the amendment that the poles shall be similar to those known as the "Providence" poles. Without discussion the board proceeded to act on the reports. The majority report prevailed by a vote of seven to five. The "leave to withdraw" thus bestowed upon the Suburban Light and Power Co. means simply a refusal to grant the petition.

The directors of the company by no means give the matter up. They had made contracts for additional apparatus and had secured the old Globe Nail Works on Norfolk avenue for a power station, on the strength of the mayor's action.

An order of notice, returnable February 18, has been issued by Judge Field, of the Supreme Court, upon the application of the Suburban Light and Power Co. for a writ of mandamus to the mayor and board of aldermen of Boston, to compel them to grant locations for poles as petitioned for by said Suburban company. Mr. Albert C. Burrage, treasurer of the company, gives the following history of its connection with the matter: "In response to the city's advertisement bids were handed in Dec. 30, and after mature deliberation and consideration by the mayor, the corporation counsel, and the superintendent of lamps, the contract was finally awarded to our company on Jan. 9. The petition for the additional pole rights was placed before the board of aldermen Jan 20, and was referred in due course to the committee on electric wires. A majority of the committee reported in favor of the petition at the next meeting, but the board, feeling that there was a great public interest in the matter, directed that a public hearing be given. At that hearing it was shown that public sentiment in these districts was almost a unit in favor of the petition, and therefore the officers of the company cannot but say that the vote of seven to five, taken by the aldermen to-day, was a great surprise to them and will unquestionably be looked upon as a severe blow not only at the interests of the City of Boston but at its good name. Although entirely aware of the enormous pressure which had been brought to bear against the petition by interested rival companies, we did not question but that the merits of the case in favor of the petition were so strong that the aldermen could not do otherwise than grant it."

Mayor Hart is reported as saying that though the Suburban company is practically killed by the aldermen's action, the city will not be the loser, as the present contractors have shown an extraordinary eagerness to retain their present position even at the 40-cent rate.

The Suburban Light and Power Co. had proposed to place their wires underground in the business portion of the city. In the course of the hearings given in the matter, much interesting information was brought out touching the electric light business in the large cities of the country. Professor John P. Barrett, of Chicago, gave facts and figures concerning Chicago electric lights and his opinions thereon. D. R. Walker, of Philadelphia, gave the history of underground wires in that city. Both gentlemen strongly favoring the undergrounding of electric light wires.

The West End road are perfecting and extending their electric motor system with great rapidity.

A novel test of the power of the electric motors in use on the West End street car system was made on Jan. 29. Three ordinary passenger cars were hooked together, two of them being loaded to the ceiling with bags of meal, huge coils of heavy rope and other compact and weighty articles. The combined weight for each car was estimated at 10,000 pounds. The chief interest of the test centered upon the steep grades at Chardon and Cambridge streets, near Bowdoin square. After the tracks were well sanded, the train was started, and the Cambridge street grade was easily conquered, as was subsequently the Chardon street grade.

The Quincy and Boston Electric Street Railway Co. have just elected officers as follows: President, John Q. Adams; treasurer, Arthur Burnham; clerk, F. H. Smith; directors, the above-named gentlemen and Josiah Quincy, W. G. A. Pattee, W. T. Whitman, F. H. McDonnell, W. A. Hodges, John A. Duggan and Winthrop Coffin.

The fifth annual report of the board of gas and electric light commissioners has been presented. In the state there are 75 gas companies, 26 of which have the right to supply both gas and electricity, and 100 electric light and power companies. Seven gas companies have been authorized to engage in electric lighting business, and there have been six cases before the board on appeal from the decisions of the mayor and aldermen and selectmen of as many cities and towns. The year was an active one for those engaged in the electric lighting business. There were 44 new electric light and power companies, and four new companies for the manufacture of gas and the electric light incorporated.

The steamer Rhode Island of the Stonington line has just been equipped with a Huntington search light, for use when a fog, mist or snow prevails. Pilots say that they have seen the projected beam of light 18 miles. The instrument is placed on the roof of the pilot house, and is worked by the pilot from within. Its candle-power is 3,000. The Massachusetts is also to have one of these lights.

The New England Port-Electric Co. are building an experimental plant of their system of conveying mails and packages in a large field on the line of the New York and New England Railway, between Mt. Bowdoin and Harvard St. stations. The track is about one mile in length, with two curves, the radius of the lesser being 200 feet with grades, switches, etc., to correspond with the conditions that will exist when used for commercial purposes. There is a power station so located that the track passes directly through its centre at a distance of about two feet from the floor, with a lookout tower, from which the entire circuit of the track is visible. It is equipped with a Sturtevant 20 h. p. engine, an "American" dynamo for lighting purposes, and an Edco dynamo to furnish current for the cars, wound for a pressure of 1,000 volts. The cars will be about 12 feet in length, 10 inches in diameter, and of one-tenth of an inch steel, supported on two wheels and steadied by a third on top. The total weight of this size car with its load will be about 200 pounds. The wheels are about 10 inches in diameter, and will run upon ball bearings which have been tested at a speed of three miles a minute without overheating.

At the meeting of the Society of Arts, February 13, at the Institute of Technology, Mr. Frank M. Gilley read a paper on the "Electrical Purification of Sewage." Mr. Gilley described the process used in England, and illustrated the method by experiment. The organic matter in the sewage is decomposed by the nascent oxygen and chlorine and may be filtered out. The experimenter tells by the appearance of the liquid when to stop the current. The sewage is then filtered and allowed to run into the river. About 24 h. p. is required to treat successfully 1,000,000 gallons of sewage per day. The second process is by means of filtering through sand and coke alternately, the coke being charged with electricity, introduced by means of carbons. Both processes could be used in conjunction. Blackboard drawings were used in illustration.

BOSTON, February 15, 1890.

CHICAGO.

Delegates to the Electric Light Convention at Kansas City Entertained at Chicago on Their Way.—A Dynamo Plant Substituted for Batteries in the Western Union Telegraph Co.'s Chicago Office.—The Chicago Electric Club; a Paper by Mr. Sperry on High Tension Motors.—The Meeting of the Western Electric Railway Association Postponed to June 11.—A New Storage Battery Plate.—City Officials Want Their Telephone Service Restored.—Corporation Notes.

THE special electric limited train, with its party of delegates to the Kansas City convention of the National Electric Light Association, reached Chicago, February 9th. Several gentlemen representing the Chicago Electric Club, met the train at Englewood, and assured the travelers that they would receive a hearty welcome in Chicago. When the party reached the station, they found carriages waiting to convey them to the rooms of the Chicago Electric Club. A large number of guests and club members who had gathered in the rooms, cordially welcomed the eastern delegates.

After a brief informal reception, the party gathered in the assembly room. President F. G. Beach, of the Chicago Electric Club, in a few well-chosen words gave the visitors a hearty welcome. Mayor Cregier made a short address, in which he alluded in a good-humored way to the World's Fair, saying he had no doubt the New York gentlemen had brought with them the warrant giving the fair to Chicago. He excited a laugh by saying of Chicago, that it was second in commercial importance in the country, and in point of territory "Heaven only knows how large."

In response to calls, Dr. Robert Amory, of Boston, George M. Phelps, of New York, Dr. A. F. Mason, of Boston, A. J. De Camp, of Philadelphia, and F. E. Degenhardt and B. E. Sunny, of Chicago, made brief speeches, heartily acknowledging the courtesies of Chicago, and its Electric Club.

Lunch was served, after which the informal reception was continued. One of the ornaments of the assembly room was a star formed of incandescent lamps. Music was furnished by a mandolin orchestra. During the afternoon many of the delegates visited points of interest in the city. A number inspected the electric light plant in the Auditorium.

The special train, with two added coaches for Chicagoans, left the station at five o'clock, for Kansas City. The delegates were unanimous in the opinion that the reception formed an exceedingly pleasant break in their long journey westward. At the close of the convention, many of the eastern delegates returned by the way of Chicago, and were entertained by friends at the club.

The Western Union Telegraph office in Chicago, will hereafter obtain its current for operating its instruments from dynamos instead of from batteries. The batteries had been accumulating until they had reached the number of 25,000 cells. They were scattered about the building and required no little attendance. It was therefore determined to make an installation of dynamos.

The plant consists of 19 Edison machines; 15 of them, under normal conditions, run at 70 volts and are the regular Edison No. 2 dynamos, wound for 125 volts at 1,800 revolutions. These generators are run at 1,200 revolutions, so that the reduced potential of 70 volts is obtained. Two of the machines are wound for a potential of from 5 to 10 volts, and two are wound for 15 to 30 volts, the speed in each case being 1,250 revolutions. The dynamos are driven by three Sprague motors, one of 10 h. p. and two of 15 h. p. capacity each. In addition to the ordinary rheostats, these motors are provided with resistances which are in shunt to the series coils. By this arrangement a nice adjustment of speed is secured. Current for the motors is taken from the Edison central station circuits.

At the meeting of the Chicago Electric Club, February 3, Mr. Elmer A. Sperry read a paper on "Operation of Electric Motors With High Tension Currents." In the course of his paper, Mr. Sperry said:—"For the transmission of power from one point to another there can be no question as to the utility and great advantage of employing high potentials. I speak now of the transfer of power from one point to another as contra-distinguished from the distribution of power for domestic or like purposes on a widespread scale. I, however, see no reason why in the near future, this latter system also should not be prosecuted along the lines of high tension currents, inasmuch as the phenomenal progress which has characterized electrical engineering enterprises in the past will bring the question of insulation to a point where danger to life and property will almost entirely cease to be an element to be considered. This will doubtless be brought about, too, by the utilization of safety devices in the central plant, as well as throughout the construction."

Mr. Sperry contrasted the relative advantages of transmitting power by constant current and constant potential, assuming in each case a potential of 3,000 volts. Mr. Sperry concluded that the constant current system was in every way the more desirable. A spirited discussion followed, in which the constant potential men had an opportunity to express their views. The meeting was one of the most interesting ever held by the club.

The Western Electric Railway Association announced that it would hold a meeting in Chicago on January 29th. As there were only four members present on this date it was decided to adjourn until June 11th.

Mr. H. G. Osburn, of Chicago, recently received a patent for a new form of storage battery plate. The London *Electrical Review*, in referring to the patent, says: "At first sight it would appear as though the plate were composed of two grids, so placed in relation to each other that the openings in one coincide with the points of intersection of the ribs in the other. Instead, however, of there being two plates, the grid is cast in one piece. Some time during last year J. S. Sellon showed us some plates of his own, identical in every detail with that of Mr. Osburn. Which of these gentlemen claims priority of invention?"

At a recent meeting of the Chicago city council the mayor and comptroller were instructed to direct the Chicago Telephone Co. to replace the telephones recently removed from police stations and public offices.

The Hyde Park Electric Light and Power Co. has decreased its capital stock from $500,000 to $100,000.

The Bear Electric Co. has been incorporated in Chicago with a capital stock of $3,000,000 by S. J. M. Bear, N. H. Hauchett and A. P. Willoughby. The company is formed to exploit a dynamo invented by S. J. M. Bear.

CHICAGO, February 19, 1890.

ST. LOUIS.

The City Lighting Contract; Trouble with the Contracting Company.—Electric Light Deals.—The Laclede Gas Company's Electric Plant.—Lamps Stolen and Broken in the City Alleys.—The Lindell Railway Co.—Other Railway Notes.—The St. Louis Electric Power Co.—The Western Electrical Supply Co.—The Citizens' Electric Light and Power Co. of East St. Louis.—The New Brighton Electric Light Co.—A Municipal Electric Plant at St. Charles.

THE Municipal Electric Light and Power Co. are having a rather stormy time with the Board of Public Improvements on account of a change from low tension to high tension system, the city contract having been awarded with the understanding that a low tension, or short arc system would be used. The promoters of the company were closely identified with the Indianapolis Jenney Electric Co., and the Jenney system was the system expected to be used. The advantages of the Jenney low tension system were set forth to the board in a very forcible manner. Lately it became known to the board that the lighting company had changed their plans to a high tension system—the Wood system of the Ft. Wayne Electric Co. This change in plans together with the apparent slow progress in completing their station, caused the board to apprehend that the lighting company were not acting in good faith, and the vice-president of the company, Mr. Chas. A. Sutter, was cited to appear before the board on February 18, to explain the delay and change of plans. Mr. Mortimer Taylor, the legal adviser of the lighting company appeared, and explained that their company had really undertaken a contract of greater magnitude than they had expected, that the time fixed for the work to be completed was too short. Mr. Jas. I. Ayer, superintendent, explained the progress and present state of the work and also the change from low tension to high tension, which was occasioned by the absorption of the Indianapolis Jenney Electric Co. by the Ft. Wayne Electric Co. last October. The Ft. Wayne company at that time were supplying a low tension system, which has since been superseded by the Wood improved high tension system. Mr. Rorison, secretary of the Ft. Wayne company, stated the reason for their change to be that the low tension lamp required a very close regulation of the length of the arc, which was a difficulty that the Jenney electricians failed to remedy, and that as the improved high tension system was far superior in every way, they had adopted it. These explanations did not entirely satisfy the board. The president, Col. Flad, asked if the real reason was not that the high tension system was cheaper to operate than a low tension system. This was denied by Mr. Ayer, who stated that they wanted to use a live system, one that is in general use, and that the low tension system had become obsolete. The board will make a test of the two systems and possibly make a trip to Cincinnati to see the Wood improved high tension lamps which are used there, in order to settle the matter in a practical way.

The Hollins syndicate, of New York, have sold out their entire interest in the St. Louis Illuminating Co. and the Municipal Electric Light and Power Co. to Laudenberg Thalman and Co., of New York. This leaves the ownership of these two companies in the hands of Laudenberg Thalman and Co. and Seligman and Co., of New York, and Jas. Campbell and other local capitalists of St. Louis. The withdrawal of Hollins and Co. was caused by a difference of policy of the two factions which could not be harmonized. This deal will probably lead the way to the consolidation of the two companies into one corporation, styled the Consolidated Municipal Electric Light and Power Co.

The electric department of the Laclede Gas Co. are pushing work at their permanent station, and will probably be able to start up early in March, at which time the temporary plant will be transferred to the new quarters. This company will use Williams's triple expansion condensing engines and will, therefore, require a plentiful supply of water. Their station is favorably located for the purpose on the river bank, and a tunnel is being driven through solid rock into the river. A shaft has been sunk at a point midway between the station and the river, and the work is now being carried on in three headings. The river tunnel will not be completed in time for the starting up in March, and the engines will therefore be used at high pressure until the tunnel is finished.

Both the Missouri Electric Light and Power Co. and the electric department of the Laclede Gas Co., who are lighting the alleys of the city, have suffered much breakage of lamps by the malicious action of boys, and not a few lamps have been stolen from the sockets. A few prosecutions which are now underway, will probably put an end to such depredations. Aside from this the alley lighting is going on successfully in every way. The inductive disturbance to the telephone service which was caused by the alternating currents of the Missouri Electric Light and Power Co. has been almost removed.

A bill authorizing the Lindell Railway Co. to extend their Washington avenue and Choteaw avenue sections to Forest Park has passed the municipal assembly, and now awaits the signature of the mayor. The bill authorizes the company to use the overhead system of electric power, the company having already adopted the Sprague system. Construction will be begun at once and pushed rapidly to completion. Mr. F. D. Berry, a Johns Hopkins man of '88, has been appointed electrical engineer of the Lindell Railway Co.

A bill authorizing the Benton Bellfountain Railway to change to cable or electric power, has passed the municipal assembly and has been signed by the mayor. The company favor electric power, but as there is some uncertainty about getting the privilege of erecting overhead wires in the central part of the city, they may have to adopt the cable.

The Short Series Railway is again in operation on the south end of the Broadway line.

Track laying and overhead construction on the Union Depot line, and also work on the power house and new car sheds is progressing rapidly.

The new gas scheme—the Metropolitan Gas and Electric Light Co.—have failed to make a satisfactory showing with their new process of gas making.

The St. Louis Electric Power Co. are erecting a power station on the corner of 2d and Christy avenue which is expected to be ready for occupation by April 1. Since the destruction of the Guernsey Scudder building last December, they have occupied temporary quarters in the basement of the Exposition building, using the Edison dynamos of the Exposition building for supplying their circuits.

The Western Electrical Supply Co. have opened an office and salesroom at 310 N. 3d street. T. J. Wilson is president and manager, and W. F. Henderson vice-president. They deal in electrical merchandise of all kinds.

The Citizens' Electric Light and Power Co., of East St. Louis, started up their station on February 8, with one 600-light Slattery alternator and one Ft. Wayne Wood arc dynamo of 60-light capacity. This company secured a contract for lighting the City of East St. Louis with arc lights, and the entire number of lights are used for this purpose. Another 60-light dynamo will be installed shortly. The station occupies a very substantial brick building erected for the purpose with adequate steam power; two Westinghouse engines of 80 and 100 h. p. are used.

The New Brighton Electric Light Co., of East St. Louis, has been incorporated. Capital $20,000. P. W. Abt, president; Martin Benzen, vice-president; T. L. Fecket, secretary and treasurer.

At an election held on Tuesday, January 21, the City of St. Charles, Mo., increased their indebtedness in the sum of $150,000 for the purpose of establishing an electric light plant to be operated by the city.

ST. LOUIS, February 19, 1890.

PITTSBURGH.

The Authorities of Youngstown, O., Examine Electric Lighting in Pittsburgh.—The Mill and Mine Electrical Equipment Co.—Success of the Sprague Motors on the Pleasant Valley Railway.—Other Railway Notes.—Trouble in Starting a Cable Road.—The Allegheny City Municipal Plant.—Visit of Electric Light Men to Pittsburgh on their Return from Kansas City.—The New Town of Wilmerding to be Lighted by Electricity.

A COMMITTEE of municipal authorities from Youngstown, O., composed of D. Atchison, chairman; M. Oberdorfer, I. G. Smith, George E. Rose and I. G. Edward, were in this city a few days ago for the purpose of investigating the Pittsburgh system of electric lighting. They also inspected the alternating current incandescent light plant of the Allegheny County Light Co. in this city and in Allegheny City. After paying a visit to the Westinghouse Electric Works they returned home. Their object in coming to this city was to get pointers here with a view of erecting a municipal plant at Youngstown.

An application for a state charter has been made by the Mill and Mine Electric Equipment Co. of this city. The incorporators are Messrs. Walter A. Giles, John S. Scully, J. W. Carnahan, W. J. Burns, J. V. Patton and F. W. McKee. This company intend to carry on an electrical construction and supply business. They own the Hercules mining machine, an apparatus which was lately brought out and is now used in the production of coal along the Monongahela valley in several mines. Its great advantage is the feature of economy. It is claimed to enable the mining of coal at less than one cent per bushel. Each of these machines is supplied with a Tesla motor, the company having made a contract with the Westinghouse Electric Co. to supply this motor.

Since the Sprague electric motor has been started on the Pleasant Valley street car line in this city, electricity has become the popular motive power for street cars in Pittsburgh and Allegheny. The system has proved a great success so far, that is, without considering a couple of accidents which cost two horses their lives and the burning out of a few dozen of telephones and fire alarm boxes. It is now very likely that electricity will be adopted by all the other street car companies. Even the traction companies, it is rumored, will soon exchange the expensive cable system for the electric motor. The second avenue line, where the Thomson-Houston motor has been adopted, will commence operations March 1.

The managers of the central traction road are experiencing a great deal of trouble in getting their system into operation. The road has been finished since the first of February, and several trial trips have been made since, but every time new difficulties have presented themselves, which retard the successful running of the cars. The road consists mainly of several very steep hills. But with all that the company is still confident of making the cable a success before long, and when such improvements have been made the city will have the third cable road.

The Allegheny City municipal electric plant is now rapidly being built, and it is expected that the entire station will be in operation by next June. The power house on Braddock street is almost completed, and the installation of the machinery will shortly be commenced. The capacity of the plant will be 3,000 incandescent lights and 300 arcs. The plant will be run by the city with the Westinghouse alternating current system.

A large number of the delegates to the Kansas City Electric Light Convention stopped off in this city on their return to the east. While in Pittsburgh all gathered under the wings of Mr. Morris Mead, the superintendent of the bureau of electricity, who accompanied the visitors over all the interesting sights, and there are many of them—of the gas city. The central station plant of the Allegheny County Light Co. was inspected, and the guests were also taken over the Westinghouse Electric Works. The visitors were very much impressed with all they saw here, and they expressed themselves not a little astonished at the great progress Pittsburgh has made during the last few years as an electrical city.

The city council of Allegheny has granted an ordinance permitting the Pittsburgh and Manchester Street Car Co. the right to change their motive power to either cable traction or electricity.

Wilmerding, a suburban town of Pittsburgh, will be lighted by electricity in a short time. This is an entirely new town, situated along the Pennsylvania railroad. It was built by the Westinghouse Air Brake Co., which has located its new works there. The North American Construction Co. has been given the contract for the construction work of the plant. The central station will start with a Westinghouse alternating current dynamo of 1,500 incandescent lights, and a Westinghouse arc light machine of 60 lamps. A 100 foot iron tower will be put up in the works with six arc lights.

PITTSBURGH, February 20, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

DEWEY'S CATALOGUING SYSTEM.

[118.]—Professor Osmond seems rather unjust in his criticism, in the February number of the ELECTRICAL ENGINEER, on Mr. Dewey's classification of engineering sciences, and it is probable that, unless better arguments than his own are advanced against it by the gentlemen who are invited to protest by letter, the classification will not be changed. Mr. Dewey has evidently either consulted competent authority before making his classification or, more probably, has borrowed it from an authoritive source.

Professor Osmond would certainly not maintain that when a species in a botanical or zoological genus attains a certain commercial importance, it should be formed into a genus by itself; yet that a similar thing is not done in another case excites his indignation.

On the other hand, and most inconsistently, Mr. Osmond complains that the name invented to differentiate that small part of engineering that at one time was not military engineering, should be omitted. In rural districts the writer has met surveyors who pride themselves upon being civil engineers, and some graduates of colleges and engineering schools who occupy minor engineering positions, or none at all, are very tenacious of the title; but where you find an engineer of note it will generally be found also that he has differentiated his title so that it means something definite, which that of civil engineer certainly does not. It is true that the title has yet an existence in the designations of public officials and is yet given as a degree; but the master of the black rod is still an important personage, and almost any college confers the degree of master of science. What is true of the title is still more true of the generic name that, in the day when one man could practice them all, embraced in their entirety the statical and dynamical sciences then developed.

It is to be regretted that the proposed substitution of dynamical for mechanical did not take place, and that more schools did not follow the lead of the University of Pennsylvania in substituting the degree of dynamical engineer for that of mechanical engineer; the march of progress is so rapid, however, that it will not be long before either title will be, as the science has already been, so differentiated that it will occupy the same position that that of civil engineer does now,—more a mark of dilettanteism than the designation of a practicing engineer. When the other specialities under dynamical engineering shall have acquired sufficient commercial importance, they in turn will be differentiated by professional names, and the sooner this takes place the better, as the result, or rather cause, will be the substitution of an exclusive course in the schools, strictly appropriate to the profession, as in the case of electrical engineering, instead of the present inclusive one given under the name of mechanical engineering. In any event, however, the scientific basis of all of the professions in the classification in question as given by Mr. Dewey, will rest on the general laws of dynamics or mechanics,—a fact that commercial importance or specific titles cannot change.

Assuming that the criticism is due to the supposed implied precedence given to the specific title of mechanical engineer as conferred by some schools, it may be asked if an examination of the two courses where given together by any of the several leading technical schools, will not show that from this point of view the criticism is equally unjustified. Such an examination will show that the greater part of the course of an electrical engineer is what was formerly considered an exclusive qualification for the degree of mechanical engineer; and, moreover, that of the remainder of the course of the former a good part is of practical value to the laboratory electrician only, rather than to the practicing engineer. In other words, the graduated mechanical engineer would require a comparatively short supplementary course in electricity to place him on an efficient footing with the graduated electrical engineer, while to the passed student of electricity, *per se*, a course almost equal to that of the mechanical engineer or its equivalent would be required to enable him to enter the same profession on a proper footing. That this should be so, follows from the fact that a plant may run for months without any derangement of its strictly electrical parts, while the boilers, engines and various mechanisms, including those about the electrical apparatus that are purely mechanical, will require constant attention, adjustment and repairs; its installation is similarly almost entirely a question of mechanical, as distinguished from electrical knowledge, and in no profession, perhaps, are special details so definitely settled beforehand for the engineer as are all the purely electrical ones by the laboratory expert or inventor before the electrical engineer, as distinguished from the former, takes hold. Thus, from this standpoint also, the divorce suggested would be an unnatural one.

To resume, electrical engineering is essentially a branch of dynamical or mechanical engineering with a specialty, electricity, from which it derives its name, and the so-called mechanical engineering of the schools is the same with, in practice, a specialty which latter will in time probably give rise to a differentiated name and title for each branch, as in the former case.

If Mr. Dewey has erred at all, it is in not following the scientific method implied in the classification of the dynamical sciences by similarly embracing as sub-divisions, under the head of statical engineering, some of the branches that are assigned as divisions.

W.

BROOKLYN, N. Y., February 15, 1890.

CANDLE POWER AND WORK.

[119.]—We are sometimes told that the radiation of the incandescent filament or arc is the pure, ethereal essence of light; the *spiritus lucis*, a manifestation of the ultimate energy of the universe, exhibited indeed through matter, but unencumbered by, and dissociated from the comparatively gross mechanism of combustion which requires an external source of heat to initiate a series of operations which finally result in the production of light.

The more sober minded of us are wont to regard these expressions as merely the effusive rhetoric of an electrical enthusiast; but a little consideration will show them to contain some truth as well as poetry. In our older methods of obtaining light by burning fats, oils and gas, the light is often but an insignificant fraction of the total work of the chemical and physical processes involved in, and indispensable to, its generation by these means; while in the electrical method the light is the main thing, there being no irrecoverably wasted products which only offend the senses, vitiate the atmosphere and consume power.

We know that heat is but an expression of the mechanical work absorbed by the friction or impact of masses or particles of matter upon one another, and observation shows that those bodies which do most work—*i. e.*, produce most heat during combustion

—give the least light. Thus, if we burn equal weights of hydrogen, coal and dry wood, we find that the gas evolves more heat than any other known substance while its flame is the least luminous of all flames; the coal yields more light than, but less than one-fourth the heat of the hydrogen; and the wood, giving far more light than the coal, produces but half as much heat.

The following table copied from the address of Mr. W. H. Preece, president of the British Association, delivered before the Bath meeting of that body, in 1888, clearly shows the amount of power per photometric unit consumed by the various substances now commercially used in the generation of light.

Substance.	Watts absorbed per candle-power.
Tallow	124
Wax	94
Sperm	86
Mineral oil	80
Vegetable oil	57
Coal gas	68
Cannel gas	48
Electricity, glow	3
Electricity, arc	0.55

From this we see that the production of light and heat are inversely proportional to one another, and this rule holds good for the radiations of the glow and arc lamps, for; though no combustion takes place in either of them, yet the quantity of matter working, producing heat in the filament, small as it is, is nevertheless great compared to the amount of carbon vapor developed and made incandescent between the poles of the arc.

This is a long step towards the solution of the problem of obtaining light without heat, which we may reasonably hope will be accomplished by the electrical engineering of no distant day; but when this is done it will not be as great an advance upon the arc light of 1890, as the incandescent filament of the present time is beyond the mediæval tallow dipped rush of the literally dark ages. HOWARD PEACOCK.

New York, February 1, 1890.

POINTERS.

.... WITH the hope of reaching remunerative results, experiments are tried by commercial companies on a scale and at an expense that could not be compassed by the physicist. What results might be reached if such experiments were always directed by scientific knowledge!—*W. A. Anthony.*

.... I HAVE seen in one of the largest hotels in New York, lighted by its own plant, the large Edison dynamo being run with blocks of ice on the bearings to keep them cool. This the engineer told me was the way he always ran the machine.—*G. S. Ram.*

.... I HAVE no hesitation in saying that if any marked improvement has taken place in the management or in the arrangement of the telegraphs of this country through my exertions, I believe it has been greatly due to the contact I have made with the energy and go-aheadedness of our friends on the other side of the water.—*William H. Preece.*

.... I HAVE never yet met an American electrician who has come over to this side of the water who has not admired something that we do, and gone back feeling a wiser man.—*William H. Preece.*

.... I DO not think there is really very much difference between American engineers and English engineers. It is the conditions of the countries that are different, and the engineers over there have adapted themselves to the conditions.—*G. L. Addenbrooke.*

.... OVERHEAD wiring, properly done, combines economy with simplicity and efficiency.—*Frederick Reckenzaun.*

.... THEORY is an effort of the imagination to account for operations that are in themselves invisible and insensible, but which result in facts which are observable and known.—*William H. Preece.*

.... JUST as an enormous advance was made in literature when signs for each idea were replaced by a comparatively few letters making words, so I am inclined to think a second great advance was made, when ideas, however complicated, were expressed by combinations of two signals only.—*Professor W. E. Ayrton.*

.... TO spend millions of dollars for an idea, or to satisfy an unreasoning or an uninformed public opinion is bad engineering. —*Ashbel Welch.*

.... HOWEVER useful the term "electrical" efficiency may be to those whose object it is to sell machines to the engineer, the "efficiency" is the useful output of electrical power divided by the mechanical power actually given to the machine.—*John Perry.*

LITERATURE.

Absolute Measurements in Electricity and Magnetism. By Andrew Gray, M. A., F. R. S. E. Second edition, revised and enlarged. London and New York: Macmillan & Co., 1889.

THE appearance of this volume at this time will be somewhat of a surprise, no doubt, to those of our readers who recall the recent publication of the first volume of Professor Gray's larger work under a similar title, which was reviewed at some length in our issue of June, 1889. In the preface to that work Professor Gray described it as an extension of his smaller book, which, published in 1884, had long been out of print, and added that the design of the smaller book would be so extended as to make the new work a fairly complete treatise on the absolute measurement of electric and magnetic quantities.

In the preface to the present volume it is explained that although it was intended that the larger work should supersede the original small book, a demand for a second edition on the original plan has led to its preparation, notwithstanding that the second volume of the more comprehensive work is now in press. In this new edition the contents of the earlier one have been almost entirely retained, although the order of arrangement of the subjects has been changed, and many of them have been considerably amplified; while much new matter from the larger work has been added. The volume has thus been about doubled in size.

The main purpose of this work, like that of its predecessor, is to explain, both theoretically and practically, the measurement of potentials and currents in absolute measure, and their application to the graduation of instruments used in practical work. The absolute units of measurement of magnetic and electric quantities are defined at some length, and it is shown how from the fundamental units the practical units of current, quantity, potential and resistance are derived. Rules are given for the calculation of currents and resistances in derived circuits, together with some novel methods of determining resistances which are not usually described in text books; while the measurement of energy spent in the circuits of dynamos, motors and secondary batteries, and the determination in absolute units of the intensities of powerful magnetic fields receive brief but careful consideration.

The measurements described are for the most part refined laboratory processes involving the use of elaborate apparatus. Thus in order to illustrate the process of graduating the scales of measuring instruments the electric balances, electrostatic voltmeters, magnetostatic current meter, and quadrant electrometer of Sir William Thomson are selected as types. No other instruments are described or even referred to, and to such an extent is the work of Sir William Thomson set forth in these pages that one may easily get the impression that the volume is in part a eulogy of that distinguished philosopher's achievements.

While it is evident that methods suitable for calibrating one type of current and potential instruments must be applicable to the calibration of other types of the same class, it would certainly not have been out of place in a work of this character to indicate some of the more tried and less expensive types of measuring apparatus. Especially as in the earlier edition of this work Professor Gray then limited himself to an elaborate description of Sir William Thomson's new graded galvanometers. Experience has since proved—in this country at least—that these instruments are unreliable and wholly unsuited to the practical work for which they were intended. Their design was defective in almost every particular, from the wooden bases which warped and stood unsteadily on three badly distributed supports, to the thin semicircular directing magnets, whose moments were continually changing and practically needed to be re-determined whenever a careful test was to be made. Moreover the movement of the magnetometer, by which the sensibility of one of these instruments was varied, could not be accurately adjusted because of the lack of suitable facilities, while the method of attaching the flexible electrodes was awkward and inconvenient. Not a hint of the existence of any of these defects was let fall in the first edition, while in this edition all reference to these instruments has been simply omitted, and descriptions of these later valuable, but complicated and expensive, instruments substituted.

While the subject of electric and magnetic measurements receives throughout this work treatment excellent in its way, it demands considerable acquaintance with the subject on the part of the student or reader, and an easy familiarity with off-hand mathematical demonstrations. The concluding chapter on the dimensions of units is particularly complete and instructive, although it can hardly be called a popular description, any more than the remainder of the book, so far as style and language employed are concerned. Several useful tables—in which some typographical errors have been noted—are appended to the end of the volume, among them one giving the numerical values of the virtual resistance of conductors carrying alternating currents, and another giving Matthiessen's constants for correcting the conductivity of metals for temperature. Throughout the text—wherever possible—the solidus notation has been adopted with a view, no doubt, to economizing space.

NEWS AND NOTES.

THE KANSAS CITY CONVENTION.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

ELEVENTH CONVENTION (SIXTH ANNUAL MEETING) HELD AT KANSAS CITY, MO.,
FEBRUARY 11-14, 1890.

The convention assembled at noon February 11, in the Coates Opera House. About 150 members and guests were present.

President E. R. Weeks took the chair and introduced Hon. J. J. Davenport, Mayor of Kansas City, who made an address of welcome.

His Honor said that many of the most important and interesting conventions that had been held in the United States during the year of 1889-90 had met at Kansas City. To none, however, had he extended in behalf of the city a more cordial and heartfelt greeting than on this occasion. "The result of the deliberations of the present convention would be awaited by the whole commercial and scientific world. By means of your marvelous agency you have presented to science wonderful aids, by which she has been able to make visible what has hitherto been invisible, to make audible what has been inaudible, and to discover what has not been dreamed of in the philosophy of mankind."

"As we hear of these mysterious currents measured by amperes, and of the power by which various bodies resist these currents measured by ohms, we seem to be attaining the condition of life of which Mr. Thurston speaks, or that is so cleverly portrayed by Bulwer in his 'Coming Race,' in which all are happy and harmonious, seeming to have reached the millennium, evil being held in bondage by the potent 'vril' wand, which gives to all alike motive, defensive, and creative power, with also the perfect knowledge of how to use it for the greatest and best good of all. Electricity is our magic "vril" wand, and you are teaching us its capabilities."

"We welcome you as true benefactors of mankind, the emancipators of the human race from darkness. What you and those of your profession have accomplished within the past years reflects credit upon your country, borders close upon the miraculous, and entitles you to imperishable honor and renown."

His Honor then briefly recounted some details of the growth of electric light and power as commercial industries, and concluded by saying:—

"To the future we can only look with wondering eyes and bated breath, and to you as the workers of miracles. May your deliberations, gentlemen, while here, be as harmonious as the laws which govern the marvelous and wonderful philosophy of electricity."

President Weeks then addressed the convention as follows:—

PRESIDENT'S ADDRESS.

Gentlemen:—At our first convention, held in February, 1885, there were 87 delegates, full of enthusiasm for the good to be accomplished. I believe they have not been disappointed in the work of this association. As one of the original 87, I point with pride to five years of broadening and harmonizing influence; and I believe that every central station, every factory, every supply company in the country, has felt its impulse toward improvement.

To-day, gentlemen, we number 304, representing not only a wider extent of territory, but all the leading systems of the United States. A more fraternal-spirit prevails between electric light and power men and our elder brothers of the telegraph and telephone interests, a pleasant proof of which has been given by the hearty co-operation of their representatives in this city, in preparing for the entertainment of the convention.

The past work of the association speaks for itself; but our number has so increased, and our sphere of usefulness has so advanced, that we must look for work of a better character than was possible in earlier days, when most of our members were new to the duties which they had undertaken. We now need work of more direct practical value to central station men, and theoretical work of a higher grade than that of the past, good as that has been. With this in view, we have endeavored to prepare a programme of such importance, both practically and theoretically, that you will find it good to be here.

The committee on state and municipal legislation will report the organization of state associations with a view to developing among legislators a full appreciation of the importance and needs of electrical industries, and to present these industries in their true light. The urgent need is for organization along the lines of legislation and popular education. This can be best accomplished by state associations, whose conventions could advantageously take the place of the semi-annual meetings of this association. Ten of these state associations have been formed, and I hope that before the close of this convention, steps will be taken toward the organization of many more.

The increasing interest in railroad work and the immense field for future development in the motor department, will render especially pertinent the discussion by Mr. Sprague, and also the work of the committee on standardization of potential on electric street railways, the report of which will be submitted through its chairman, Mr. Lynch.

As the growth of our industry must be chiefly in the direction of incandescent light and of power, the discussion to be presented by Mr. Field is of the greatest importance, both to central station men, and to all who desire electric service in their homes.

The watch-words of the future are certainly economy of fuel and perfect insulation, and, while there may be improvements in designs for apparatus and in methods and means of distribution, and while we still hope for the direct conversion of the energy of coal, the advance of the immediate future should be in the direction of economizing present waste, rather than in the discovery of new facts or principles. (Applause.) Americans are proverbially prodigal, and there is an absolute and growing need that waste and loss should be arrested. While the demand for the necessary elements is increasing with the population, the supply of many of those elements is steadily diminishing. Messrs. Babcock and Sickles will doubtless point out lines of economy in the department of steam engineering, and Mr. Smith will present for our consideration another phase of the same question—"A Universal System of Central Station Accounts." The many problems arising in the electrical and mechanical departments of the operation of central stations, have left this question to general neglect. But now that we are becoming passably familiar with the tricks of our apparatus, attention is more and more directed to data for comparison, with a view to economic methods.

The topic of the hour is certainly safety. It would seem that, in view of the relatively small number of serious accidents connected with electrical industries, we have grounds for some impatience with the present outcry against electricity as a dangerous servant. It is true, that, compared with those which have accompanied the introduction and use of steam and gas, the number of accidents in the use of electrical apparatus is very small. But in this age comparative rates will not be accepted as answers; the people have a right to demand that devices for public safety keep pace with development in other directions. The papers of Professor Thomson and Messrs. Haskins and Harber, will present this current topic in its various phases. I trust that each speaker will enforce the importance of good construction and maintenance on the part of producers, and proper inspection on the part of the municipality.

It is hoped that the committee on underground conduits and conductors will be able to report some facts regarding the actual operation of high pressure currents underground. Thus far, discussion on this topic abounds in theory and speculation, but contains little experience.

During the past twelve months there has not only been a greatly increasing activity in electrical industries abroad, but many millions of foreign money have been invested in the electrical properties of America. It is worthy of note that our brethren in Great Britain have set the example of adjusting differences amicably instead of carrying litigation to the court of last resort. Such a policy in America would not only have saved hundreds of thousands of dollars now charged to profit and loss, but would have greatly enhanced the value of electrical securities.

The past year has furnished instances in which the value of local electrical properties has been greatly depreciated through the invasion of territory already fully occupied. This policy is short-sighted. Prices in most cities are fair and just both to consumer and producer. To depreciate them will not only ruin the business of pioneer companies who have invested large sums, and borne the brunt of introducing a new and valuable industry, but cannot fail to result in great loss to the invader.

Although electric lighting in this country has seemed to receive a check, a look ahead should not be discouraging. The law that "action and re-action are equal and in opposite directions," applies not only to mechanics, but to public opinion. As America is the birthplace of the commercially successful electric light, and as Americans are the foremost people of the world to recognize improvements, we may well believe that with proper attention on our part to our duties to the public, the present popular and largely sensational agitation against us will give place to a feeling of confidence. In the meantime, let the outcry teach its proper lesson to all engaged in the electrical business. (Applause.)

After the calling of the roll, the report of the treasurer and secretary, Mr. Allan V. Garratt, was read, as follows:—

REPORT OF THE TREASURER AND SECRETARY OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION, DECEMBER 31, 1889.

Balance from account rendered July 31st, 1889, at Niagara Falls	$1,096.93	
Dues from 51 members	1,020.00	
	$2,116.93	
Expenditures as per accompanying vouchers, Nos. 87 to 112, inclusive		$1,506,76
Balance, cash on hand, December 31st, 1889		610.17
		$2,116.93
The indebtedness of the association is an unpaid bill of		259.60
The above expenditure of $1,506.76 for the six months ending December 31, 1889, may be classified as follows :—		
Postage		$48.52
Stationery and printing		143.90
Official stenographer		85.87
Rent of office		50.00
Advertising		46.99
National committee on state and municipal legislation		98.65
Salary of treasurer and secretary		999.96
Expenses not specified above		33.37
		$1,506.76
The total receipts for the year 1889, have been, including the balance from the previous account	$5,845.55	
Total expenses for year of 1889		$5,235.38
Balance, cash on hand, December 31, 1889		610.17
		$5,845.55
The expenditures of the year 1889, may be classified as follows :—		
Old bills incurred previous to 1889		$1,483.82
Salary of secretary and treasurer, 12 months		1,999.92
Clerk hire		40.00
Postage		176.48
Printing and stationery		712.19
Official stenographic reports		246.62
Rent of office		207.50
Advertising in electrical journals		101.99
National committee on state and municipal legislation		98.65
Not otherwise specified above		168.21
		$5,235.38
The net income for 1889 was	$5,545.82	
The running expenses for 1889, were		3,751.56
Excess of net income over running expenses		1,794.26
		$5,545.82

Membership.

Total number of members July 31st, 1889	251
Members added between July 31 and Dec. 31, '89	21
Total	272
Members resigned between Jan. 31 and Dec. 31, '89	13
Making total membership, Dec. 31, 1889	259

It will be noticed that the above reports close December 31, 1889, which is the end of the fiscal year. Since then I have received funds in the shape of dues, and have added a number of new members to the roll of the association.

The secretary's report was accepted.

The secretary then read a number of communications offering courtesies to the convention, including an invitation from the Commercial Club, of Kansas City, to a reception, Tuesday evening, February 11th; a letter from Mr. W. H. Briethaupt, president of the Engineers' Club, of Kansas City, tendering the privileges of their club room to the association during the convention; a communication from Mr. J. H. Veitch, general agent of the Chicago, Milwaukee and St. Paul Railway, inviting the members of the association to visit the health resort of Missouri—Excelsior Springs—and offering a train on Wednesday, the 12th, together with a similar invitation from Mr. Edward Holden, president of the Excelsior Springs Co.; a letter from Mr. William Wiley Smith, secretary and superintendent of the Missouri and Kansas Telephone Co., extending congratulations to the association and offering telephonic facilities.

Letters were also read from the governor of the National Home for Disabled Soldiers, at Leavenworth, Kansas, inviting the association to visit that institution; and from Mr. Geo. W. Warder, tendering to the association, a reception at the Warder Grand Opera House, Friday evening, 14th.

On motion, the above courteous invitations were received with the thanks of the association, and arrangements for their acceptance left in the hands of the president and executive committee.

The president announced that the reception committee invited the delegates and others from a distance, attending the convention, to make the rounds of the city in the afternoon, on the cable cars and elevated railroad.

On motion of Mr. F. Degenhardt a committee was appointed by the president to prepare suitable resolutions touching the death during the year of Mr. C. McIntire and Mr. Miles W. Goodyear. Messrs. Degenhardt, Candee and Garratt were named as such committee.

The president announced that the reception by the Commercial Club, would take place at 8 o'clock in the evening.

The convention then adjourned to meet in Music Hall, at 9 A. M., Wednesday, 12th.

WEDNESDAY, FEBRUARY 12—MORNING SESSION.

The convention was called to order in Music Hall, at 9 A. M., President Weeks in the chair. The secretary read a communication from R. J. McCarty, manager of the Metropolitan Street Railway of Kansas City, extending to the members of the association the privilege of riding free over its lines.

A communication from the Missouri State Association of Architects, in session in Kansas City, was presented, extending to the convention the courtesies of the Association of Architects, and inviting an inspection of the exhibit of architectural drawings.

REPORT OF COMMITTEE ON COPPER DUTIES.

In the absence of Mr. Chas. A. Brown, chairman, Mr. Geo. M. Phelps was called upon to report for the committee appointed at the August convention to memorialize Congress for the abolition of duty on copper.

Mr. Phelps reported that in behalf of the committee he had presented to the House Committee on Ways and Means, at Washington, January 16, the following petition :—

Petition to the Honorable Committee on Ways and Means, House of Representatives, U. S. A.:—

The subscribers were appointed a committee to petition your honorable body for the abolition of duty on copper ingot, plate bars, rod and wire. We represent the National Electric Light Association, a body composed of representatives of electric lighting companies throughout the United States, and also manufacturers of and dealers in electric lighting apparatus and supplies. The resolution appointing this committee was passed without a dissenting vote. We, therefore, have the honor to present this petition, earnestly requesting that the action asked to be taken as a measure, will be approved by the great body of users and manufacturers of copper.

CHARLES A. BROWN,
[Signed] GEORGE M. PHELPS,
J. F. MORRISON.

The presentation of the petition had been accompanied by a brief address to the Committee on Ways and Means, setting forth the reasons which impelled the petition. [The address was printed in the ELECTRICAL ENGINEER for February, page 74.]

After reading the address as part of his report, Mr. Phelps continued :—

The committee has circulated an auxiliary petition in support of that presented in behalf of the association. It has been intended to solicit the signatures of all companies, firms or individuals engaged in electrical industry, and to offer opportunity for signing to all other persons accessible to the committee who are in sympathy with the proposed measure. On the 8th of February, 440 signatures to such auxiliary petitions were forwarded to the Committee on Ways and Means of the House of Representatives. Your committee are still engaged in circulating copies of the auxiliary petition, and hope to collect several hundred more signatures. The committee would earnestly request any members of the association, or others, inclined to sign the petition, who have not received a copy, to address either member of the committee, viz.:—Chas. A. Brown, 227 South Clinton street, Chicago; Geo. M. Phelps, 150 Broadway, New York; J. F. Morrison, 15 South street, Baltimore.

I wish to suggest further that members who feel deeply interested in this matter would, I think, contribute to the success of the petition by addressing communications to their several representatives in the National Congress. It seems somewhat problematical, whether any discussion of the subject of revenue will be permitted to take place on the floor of Congress this session. But, if such a discussion can be brought about there, it is the opinion of your committee that the success of their petition is exceedingly probable. There is practically nothing to be said in favor of retaining the duties on copper. I have not heard a word in defense of them. The only persons who have been at all disinclined to sign the petition, have been those who have said substantially, "Yes, it is all right; the duty on copper ought to go, but we make something else and our friends make something else that is protected by tariff duties, and we do not want this thing stirred up." We feel that the greatest difficulty will be in getting the thing "stirred up." If it can be "stirred up" and brought to the attention of the National Congress on the floors of the House of Representatives, it is my individual opinion, and I think the belief of the rest of the committee, that the copper tariff will not last long.

I am the only member of the committee present. Mr. Brown, the chairman, is unable to attend, and Mr. Morrison, also, is unfortunately prevented from being here. I have made out this report after conference with Mr. Brown, but have not beenable to see Mr. Morrison.

I ought to say further, perhaps, as a matter of record, that there was no appropriation made for the work of this committee. Your committee have expended a considerable sum of money, a good deal of printing and postage being required. In due time, when we are through with our work, we may present, for the information of the association, a record of this matter.

The President—Gentlemen, this subject is a matter of great moment. Aside from its national, I might say international interest, it is a matter that comes right home to every one engaged in electrical business; and it illustrates very nicely the community of interests that prevails, and we should all appreciate and under-

stand it. Whatever affects the manufacturer of electrical apparatus affects the user of that apparatus, and what affects the user of that apparatus must necessarily come right down to the user of the product of that apparatus—the general public.

A motion that the report be received and the committee be continued, was adopted.

REPORT OF COMMITTEE ON UNDERGROUND CONDUITS AND CONDUCTORS.

The secretary read a letter from Mr. Eugene T. Lynch, Jr., chairman, Committee on Underground Conduits and Conductors, stating that the committee had been unable to hold sessions. He suggested that "the convention appoint a committee with the idea of bringing in some of the 'new blood' of the association into this active and interesting field. The experience to be gathered from the operation of such wires as have been buried in New York city (most of which have proved failures up to the present time) can be easily gathered in time to report to the next meeting of the convention."

The report was received, and the committee discharged.

REPORT OF COMMITTEE ON STANDARDIZING OF POTENTIALS.

Mr. T. Carpenter Smith read the following report:—

In behalf of the committee appointed at your last meeting for the standardizing of potentials for electrical apparatus for street railway systems, I would present to the association the following report:—

It was deemed advisable by the members of the committee to send out a circular to all railway companies operating their systems of car lines by electricity notifying them of the appointment of this committee, and asking not only their co-operation, but also drawing their attention to a number of questions that we desired they should reply to. Acting upon this conclusion, the committee drew up and mailed to all these companies the following circular:—

> *Gentlemen:*—At the semi-annual meeting of the National Electric Light Association, held at Niagara Falls, on August 6th, the following resolution was offered and adopted:—
>
> "WHEREAS, It is the belief of the members of this association that the electric motor service upon street railways will require a service of electric current for the motor that will be reliable and constant, and that the various electric light stations are capable of generating and distributing such current,
>
> "*Resolved*. That a committee of three be appointed by the president, who shall endeavor to make such arrangements with the manufacturing companies that they shall adopt some standard potential to be used upon the various railways. The committee also to collect such data regarding the supply of current to railways as may be deemed of interest to the association."
>
> The president appointed Messrs Eugene T. Lynch, Jr., of New York, T. Carpenter Smith, of Philadelphia, and Marsden J. Perry, of Providence, as members of that committee.
>
> It has been thought advisable to collect and compile the opinions and the experiences of such street railways as have adopted electricity as a motor power. Will you, therefore, kindly fill out and answer such of the following questions as you feel you can answer.
>
> 1. What system do you use?
> 2. What proportion of your cars are equipped with motors?
> 3. Do you generate your own electrical power, or are you supplied by an electric light station?
> 4. What proportion does your greatest average horse-power in use bear to the total horse power of engines and boilers which you have installed?
> 5. What is the voltage or pressure of your generators?
> 6. Is there any other railroad in your town using an electric system? If so, what system do they use, and do you know the pressure at which they run?

We have received replies from 85 per cent. of all the electric street railway companies. They have one and all showed every disposition to give us full reports upon the questions that we have asked them, and have stated that they would afford us every facility that lay in their power, and that they desired us to convey to the National Electric Light Association their hearty indorsement of this plan.

We think it advisable to divide our report into three parts:—First, a statement of the conditions under which the various railways have been operating up to the present time; second, the report of your committee upon the arrangements made with the manufacturing companies; third, all of statistics carefully compiled from reports made by some of the most prominent central stations showing the advantages that will accrue to the investor by the combined operation of the electric light and electric street railway interests working under the agreements that have been promised to your committee.

First.—Under the first question we do not desire to give any statements regarding the number of railways that may be operated by any particular company beyond the fact that fully 90 per cent. of all the railways now in successful operation are operated under the systems controlled by the Thomson-Houston and Sprague companies.

In answer to our second question, we find that at least three-fourths of the railways have equipped all their cars with motors, and that the sizes of the motors upon the cars vary from 7½ to 15 h. p.

Third.—Only nine electric light companies have been brave enough to agree to supply the street railway companies with their power, although in nearly every case when the railway was in operation there was at least one central station company who could have contracted to supply the necessary current.

The answers to the fourth question give to your committee the information that will prove of value to the association. In all railways operating over 15 cars, only one-third of the total horse-power with which the plant has been equipped, has ever been called for at one time. On all roads operating between 5 and 15 cars the greatest average load has not reached 50 per cent. of the total horse-power, and upon smaller roads the average load has varied from 50 to 80 per cent. of the total horse-power. All roads that have met with heavy grades have raised the average very considerably.

We find that the potential varies from 220 to 800 volts. The greater number of companies, however, report using a potential between 450 and 550 volts.

Our sixth question was directed partly as a check upon our being furnished correct information upon the names and locality of the various roads, but mainly to ascertain whether an opportunity was afforded to operate several street railway companies from the same central station plant.

The answers to this have been many and curious. In some cases they have disowned all knowledge of the existence of any other company, and in nearly every case they seem to be imbued with the rivalry quarrels or misunderstandings of the various patent or manufacturing companies whose apparatus they are using. They agree, however, that they would be willing to use the power supplied to them from some central station, provided that they be assured by the company who equipped their road that the potential of quantity of current used would not be detrimental to their apparatus.

Copies of the circulars, together with a letter explaining more fully the plan suggested by your committee were sent to all the manufacturing companies. They were also requested to furnish the committee with a list of the particular railways operating under their systems. After much correspondence and many personal interviews, your committee would announce that they have written authority from both the Thomson-Houston and Sprague street railway companies that they will agree hereafter to use a standard potential of 500 volts upon all electric street railway equipments that do not require any special apparatus for their successful operation.

In recommending electric light companies to add to their regular central station business the business of furnishing power to street railroads, we wish it fully understood that we do not base any hopes of profits to be made upon the old-time idea that the same machinery can be used for furnishing light at night and power in the daytime. This specious argument has led many companies into large expenditures for motors, etc., and they have discovered later that it costs very nearly twice as much money to run the same machinery night and day as to run it at night alone, and that it pays better in the long run to have an entirely different class of apparatus to produce light and power.

The true direction from which returns may be expected in the massing in large stations of the generation of electricity for both light and power, is found in the fact that an electric light station to be sure of a continuous running, requires a reserve of from 15 to 25 per cent. of its average load in boilers, engines and dynamos; the per cent. being larger in small stations and diminishing as the station increases in size.

This same reserve in capacity is required for the power station, but on street car work in most of the stations hitherto installed, this percentage runs very much higher, being from 50 to 80 per cent. It will be manifest to everyone on a little reflection, that a station which is generating current for two street cars, is compelled to have power enough provided to allow of the throwing on at the same instant of both these cars, that is to say, generating capacity of fully twice the average amount of power, or 100 per cent. reserve; as more cars are added, the chance of any particular number being thrown on at one time becomes less and less, until in a station operating 200 cars, a single spare generator to take the place of any one which might be disabled, would probably be all the reserve needed. This feature is shown very clearly in the running of the ordinary three-wire electric station, where when the total load is light a few lights thrown off or on either side will make a big difference in the balance, but as the total load increases, the number of lamps thrown off or on either side at any one instant is so small a percentage of the total load that the station needs practically no balancing. Now if in any station supplying electricity for all purposes in a town, we have say 25 per cent. reserve in boilers, and 25 per cent. reserve in steam engines in excess of the average load, we shall only require to place 25 per cent. reserve, each, on electric light dynamos and power generators to have practically the same result, as though we had two complete and separate stations for electric light and for electric power, each with its proper reserve of 25 per cent. extra in engines and boilers and dynamos.

Another important point to be considered, and one well worthy of consideration by electric light stations, is, that in many cases they could furnish this current delivered at the walls of their stations; that is, the car company will take care of its overhead lines and connections, and the electric light companies be paid a rental simply for the electricity delivered to the car companies' lines.

As an instance of what may be done in increasing the output of a station, without corresponding increase in expenses, we quote the case of a small station, which, as nearly as can be determined from results, shows the following condition of affairs :—

The station increased its business in 1889 over 1888, 23 per cent., and in the same time the total expenses including the extra line work and distribution expenses 10 per cent., which 10 per cent. meant 10 per cent. increase in running expenses and 10 per cent. in fixed expenses. The company contemplates a further increase of 27 per cent. on the same basis ; this increase, however, being for power furnished alone, without any line work involved ; the most careful calculation shows that this will only increase the present running expenses 10 per cent., without increasing the fixed charges at all.

In 1888 the proportion of fixed charges to running expenses were 25 per cent. and 75 per cent. respectively of the total expenses. In 1889 this same proportion held good, each having been increased 10 per cent., as above stated, and the total expenses having increased the same amount. The further expected increase being 10 per cent. of 75 per cent: will mean an increase in the total expenses in 1890 over 1888 of 17½ per cent., while in the same time the total output of the station, and consequent gross receipts, will have increased 50 per cent.

These figures are all taken from the case of a small station, with a total output of some 350 h. p. and a fresh increase in this station (above this point) will result in an entirely different condition of affairs, so that a readjustment will take place in the proportion of fixed expenses and running expenses. We therefore present the report of another station which is operating 1,200 h. p., in which the total operating expenses are divided into 80 per cent. running and 20 per cent. fixed. On increasing the station to an output of 1,800 h. p., the increase to be entirely in the furnishing of power, the increase on total operating expenses would be about 14 per cent., and the ratios of fixed and running expenses would be as 15 per cent. and 85 per cent.

The report of another large central station operating at least 2,500 h. p., has been divided somewhat differently. The fixed charges are 14 per cent. of the total expenditures. All labor and pay-rolls amount to 41 per cent., and all material such as coal, carbons, lamps, wire, oil, etc., amount to 45 per cent.

Taking in account all their past calculations and experiences, they are very confident that they can operate at least double their present output, be it light or power at one-fifth more for fixed charges, one-third more for all labor and pay-rolls and say three-fourths more to their present material item, making a total additional charge of say 50 per cent. upon their present expenditures and giving them in return at least double the gross income. As stated before, it will not be found advisable to calculate upon using the same engine, boiler, and dynamo power for the double service for lighting at night and power during the daytime, except, of course, in some few isolated cases.

The great saving for the central station company lies in the reducing in labor and fixed charges, and also that the reserve power for one will suffice for the other. Your committee feel that a great step has been taken in the right direction in securing the indorsement and co-operation of the largest and leading companies, and they would suggest to the association that some measures be taken to secure from the stationary motor companies the adoption of some standard potentials for their use upon constant potential circuits.

REPORT OF THE COMMITTEE ON HARMONIZING INSURANCE AND ELECTRIC LIGHTING INTERESTS.

Mr. P. H. Alexander read the following report :—

The committee on harmonizing the insurance and electric lighting interests was continued at your session, held at Niagara Falls last August, and requested to confer once more with the fire underwriters regarding the best means of preventing fires from electricity, and to try and bring about a reduction of insurance on the buildings lighted by electricity. The committee has had many sessions, and a great deal of correspondence with fire underwriters, and can only reiterate the recommendation made at the last meeting of this convention regarding the desirability of examining and licensing men employed in electric lighting, and would further recommend all electric light companies to contribute toward the remuneration of several expert electrical engineers in different parts of the United States, who should instruct special agents or inspectors of insurance companies in the necessary knowledge to discern between good and bad electrical installation. The committee thinks that special agents and inspectors of insurance companies ought to qualify themselves in inspecting electrical installation, as far as fire is concerned, the same as they qualify themselves in inspecting other appliances put up in buildings, and judge of their relation to fire hazards. The committee realizes that as long as inspectors are employed at the expense of the electric light companies, underwriters will take no pains to acquire for themselves the necessary knowledge to inspect such risks. The committee would, therefore, recommend to electric lighting companies the appointment of an instructor to special agents for a period not exceeding one year, feeling certain within that time every special agent and inspector of fire risks could acquire all the necessary knowledge to enable him to judge of electrical installation as far as it applies to fire hazards. The committee has communicated this, its ideas, to underwriters' associations and insurance boards, but must confess that it has not met with the favorable responses to this proposition that it anticipated; however, the insurance interests seem to be willing to take some steps to bring about the harmonious relations so much desired. Your committee was also instructed to report upon the advisability and feasibility of a mutual insurance company for insuring central stations. A plan was proposed by S. E. Barton, and Captain William Brophy, both of them well known to you, for the establishment of such a mutual insurance company, a prospectus of which is filed herewith, and has been forwarded to the members of this association. The committee after carefully considering the plan of operation as prepared by these gentlemen, has unanimously indorsed their ideas, as have a great many central station men of note, members of this association, as well as of the association of Edison Illuminating companies. The plan proposed will not only reduce the cost of insurance, but will aid in perfecting the construction of central stations; and by frequent inspections will aid the managers of such stations in the knowledge of modern appliances. Your committee would be glad to have this matter freely discussed here to-day to see if the project is not worthy of the official indorsement of the National Electric Light Association.

DISCUSSION ON INSURANCE REPORT.

Mr. George Cutter, of Chicago—We find constantly people who want their work done according to insurance rules. We have no uniform insurance rules; one engineer works upon one line of rules, and another upon a different line. I feel that if a committee composed of electric light and insurance men would work together to outline a national line of rules for electric installations all over the country, we would all be benefited by it. The necessities of the case have given rise to a lot of consulting engineers throughout the west. The uncertainty among purchasers of electric light plants, from the many contradictory statements made by salesmen, has made a demand for consulting engineers, and this is being filled in a very unsatisfactory manner. These men are opening offices and traveling about as consulting engineers, and among them are many who have no practical experience whatever in putting in installations. I feel that a superintendent of installation should pass an examination. This would sift out these so-called electrical engineers, whose knowledge extends, perhaps, to the putting up of a vibrating bell, and who know absolutely nothing about electric light plants. The inspection of an electric light plant requires experience in installing and handling apparatus. I believe in the value of a standing committee of electric light and insurance people working in harmony, to keep pace with the growth of our industry, so that we may know the best method of installation. New ideas are advanced constantly, with a diversity of opinion as to the correct use and installation of apparatus. The result of the work of the proposed committee, would be that the public would gain that confidence in electric lighting which it deserves, and the purchaser of electric light apparatus would have information as to what good installation is.

Mr. T. Carpenter Smith, of Philadelphia—I am much in favor of such a committee as has been recommended. I represent a company in what is usually called a slow-going town, but we have made some progress. We have an insurance inspector, who has taken an original course. He absolutely refuses to lay down any rules for wiring, on the ground that just as soon as an absolute rule is made, just so soon will be found the means to evade it. He has also been opposed to the licensing of wiremen, on the ground that while you may very easily control by a license system the extent of a man's knowledge, you cannot control his trustworthiness. We have men doing wiring as contractors in Philadelphia who can pass any examination. Yet these men will deliberately splice underwriters' wire on the inside of a building, and splice waterproof wire on the end of it where it comes out, and will wrap tin-foil around the splice, so that it looks as if it were soldered. Now, no licensing system will control men like that. Common sense is more important than electrical knowledge in wiring, especially about central stations. In the early history of the art underwriters' wire was cleated to the floor and run through a house without any rubber around it, and it was thought good enough. Then we had a scare about the water-proof business, and everybody lumbered up with rubber-covered wire and other things. Then we got to running rubber-covered wire on glass insulators, and thought that was just the thing ; but a day came when we found that the rubber cover carried the flame better than the electricity did. Now we have got down to porcelain and glass insulators. We have begun to find that our old despised friend, underwriters' wire, is not a bad thing to go through a building, because while it may get wet, it will not carry the flame. I think 90 per cent. of the little troubles occurring in Philadelphia come from the flexible cord which has been handled until all the strands are broken. All at once a little blaze is discovered in the ceiling. In Philadelphia a scheme has been formulated which has the germs of good in it. The lighting companies cannot compel a customer to have his building wired properly.

There is no question but that the insurance people can compel a customer to do anything. The worst class of customer we have to deal with is the very one who is scared the most about having insurance taken off his building, and a mere suggestion or hint from his insurance company that it will not continue his policy, will bring him to terms in a moment. We should attempt to throw the onus of all compulsory work on the insurance companies.

We are talking of an arrangement whereby the electric light companies are to pay an annual sum to the insurance companies for every arc light installed, and for every incandescent light installed. This is to apply to the maintenance of a staff of skilled inspectors, who shall not merely inspect all new work, but shall periodically inspect all work already installed, so that any changes may be examined, and any man who is found sticking 50-candle lamps on a wire that was meant for 10's can be detected. This practice will be stopped by a power that is greater than that of the electric light men—the threat of withdrawing insurance. The matter comes to this:—That a certain sum has to be paid every year for skilled supervision and inspection of all new work and all work already installed, the cost of this inspection to be divided pro rata among every user of incandescent and arc lamps, the only difference being in the case of people who are supplied from central stations, that the central station shall bear that expense. I think that the cost of such a system would be ten times paid to an electric lighting company every year, in the satisfaction they would have of knowing that somebody else was responsible for the condition of their numerous wires. The gas companies started, just as we have, by piping people's buildings and doing everything of that kind. Gradually they cut off these luxuries, and now they have got down to delivering gas at the customer's premises. They put their meter in and are responsible for it, and beyond that they are not responsible; and the electric lighting company must get there too just as quickly as possible.

Mr. M. J. Francisco, Rutland, Vt.—Mr. Smith has overlooked the fact that in New England we have an association of the very kind that he desires in Philadelphia. It is the New England Electric Exchange; and we have also the New England Insurance Exchange. The two are working together as one body, practically; that is, the orders of one go into the other and they are enforced by one organization.

If they have proper men in Philadelphia to examine wiring, I do not think they will find much tin-foil in place of solder. At least if they ever try that with Captain Brophy as inspector, they will get terribly left. He is the inspector for New England. But there, we have this plan: These men are licensed. One of the conditions that has to be considered is the moral character of the man. That man must have a record; he must have a standing, or he cannot procure a license. All buildings have got to be wired in accordance with the rules of the Insurance Exchange. After they are wired, the electric lighting company invites the exchange to send its inspector. If they are in accordance with the rules of the exchange, as well as of the company, they are passed; if they are not, they must be taken out and be put in as they should be. The moment owners refuse to do that, not only do they receive the electric lighting company's order to discontinue the current, but they have the Insurance Exchange to deal with, which cancels every policy on the property. That is the basis on which all this business should be carried out through the whole United States.

I have always been a little skeptical about mutual insurance, but in the scheme proposed in this association and practically indorsed, we shall have at the head two men who have had as long and as varied experience probably as any men in the United States. With their experience and knowledge at the head, I consider that we have a plan that we can all heartily indorse, and one which will give us insurance at its actual cost. In the last year I have received 150, if not 200 letters, asking, "Why cannot we get our property insured, and how can we arrange our stations so we can insure them?" I have had other letters saying, "The insurance companies are charging us five per cent. on our station." Of course there is some reason for that; companies do not do such a thing unless there is a reason; but in many instances, it is because the companies do not understand the rules and principles for arranging stations. The insurance companies, in a large number of cases, have inspectors of insurance risks, who know little or nothing about the electrical part. We want inspectors who thoroughly understand the electrical part of the risk. I am heartily in accord with the movement before us, and I trust every station man will investigate the matter and take hold of the subject in the proper spirit.

A national exchange would be too extended to be practical. We have now the New England Exchange, then we will take in the middle states, then the western states, the southern states, so as to make a department each by itself, the same as the insurance companies do at the present time. Divide up, but have all under one head in the national association.

Mr. J. E. Lockwood, of Detroit—This, it seems to me, is the proper time for the National Electric Light Association to make use of the state associations for the purpose of getting direct communication with each local organization in the country. The matter depends, I think, upon the organization of the electric lighting interest in each state and city. As there are electric light interests in each city, so also are there companies in each city, and the national association is represented in the local organization. I think if this committee is formed, its function could be more properly performed by formulating the ideas derived from men of experience all over the United States, and which information could be gathered and furnished by the state associations. Then let each state association apply in its own state this information and instruct all of the electric lighting companies, and the insurance men throughout the state, with the proper rules for wiring; and then through its own members, residents of every city of the state where there are electric light plants, see that these rules are carried out. In Detroit we have had the same thing to look out for. We have just formed a state association. There are probably at present not less than a half dozen different companies doing wiring of buildings, in one of which that I know of, the wires are being concealed within the mortar; and for a single light they are putting in No. 20 wire, which I know is smaller than is thought proper. We have fortunately not had a great many fires; but we have had our attention called to these facts, and the number of accidents in other cities which have been published in the papers. Our state association intends making its best effort to investigate thoroughly this matter of wiring, and to formulate rules and endeavor to carry out those rules. We shall look over the work of the state and see that no work is done in future that will not be strictly good electrical work. I trust that when this committee is formed that it will carry out this work in such a manner as to make the state associations the mediums of communication between the National Electric Light Association and the people whom we are going to reach.

Mr. T. Carpenter Smith—I do not want Mr. Francisco to suppose for an instant that we allow such a state of things as I spoke of to exist when we know of it. The point I wanted to make was that the moral character of the wire man was only good when you know it. We have had a good many bank presidents and cashiers who were very worthy, responsible and trusty men—until they went to Canada. And it is the same way with the wire man. He is all right until you catch him. And in order to catch a man's moral character you have got to have some way to defend yourself from that man after you have found him out. Now, as I say, our record in Philadelphia on the question of fires shows we have a good system of inspection there; that is, that the work has been well done. But where a wire man is at work on the sixth or seventh floor of a building and he has got one more joint to solder, it is an awful temptation to that man to twist a little copper wire and let that slide in a place where it will never be opened. You take a building with 3,000 lights in it, and there are a good many of such, where every foot of wire is concealed, you would have to put half a dozen inspectors on that one building, the whole time the work was being done to know that every joint was soldered. I am strongly in favor of a committee of this kind; but the point I want to make is, that we must look more to getting honest work, than to laying down rules that can be evaded. You must make it a question of principle. I would like to see some system devised which would be practicable, and leave the question of rules as much in the background as possible.

In stations there is no necessity for concealing work of any kind. The rules that govern ordinary fire risks, I think apply more to central stations than to any other buildings. I think there is infinitely more danger in the electric lighting stations from the boilers, engines and heating apparatus, than from the electric lighting wires, except, of course, the habit of throwing water on machinery that gets heated up, and I guess none of us would think of that, although we have heard of such things being done.

Mr. Cutter, of Chicago—About four years ago, I think, the New England Exchange was started. I like the idea of it. But must we wait four or five years for an exchange in the west, and then another lapse of time for one still further west, and then finally join them in the national exchange? Can we not start the ball rolling to-day and from the National Electric Light Association have a national exchange that will establish the necessary organization? We do not want to wait longer in the west for the good results that you are getting in the east. We want if possible to start some sort of bureau or exchange that will be a national affair, that will be the centre of information for the best class of work and the best policy to be pursued in putting in our plants. And we want, if posssble, to start from this association and at this meeting. The New England Exchange has a sound policy. I feel that if the wire men of experience and the men who are working on important parts of construction are required to have a certificate from certain associations, and that when any wire man carrying such a certificate is caught leaving an unsoldered joint, or covering a joint with tinfoil, he must lose his certificate, that is something more than a moral power. It is bread and butter for the next week or six months, and he will not want to lose that certificate. We want this committee to be appointed on a basis, if possible, for prompt action, to organize the National Electric Light Exchange, if you want to call it so.

Mr. De Camp—As Mr. Cutter just remarked very pertinently, we do not want to wait four or five years to educate up a corps of competent construction men. Let this very admirable committee devote its attention to the education of a corps of first-class inspectors from among the construction men, with a view to their employment by the insurance companies. The consumer will give his inside wiring to the lowest bidder ninety-nine times in a hundred. He has no means of knowing whether it is a proper piece of work or not, but he will believe the insurance men. He has an interest in his insurance. If it is a question whether he will dispense with insurance or dispense with our light, he will dispense with the light every time; but if it is generally known that the insurance company with whom he is doing business has a competent inspector, then that contractor must do that work under an educated and thoroughly competent inspector.

I suppose there are fifty, maybe a hundred, so-called construction companies in the city of Philadelphia to-day, and when we have occasion to discharge a workman the chances are two to one that he will turn up in time as an electrical engineer. Without a dollar of capital they will take a bid on a contract amounting to a thousand dollars. They manage in some way to get their goods; they will say they have such a contract, and want $400 or $500 worth of goods and cannot pay for them until they finish the job, and when they get paid for it they will turn the money over. Now, if those men are watched and cannot get their work passed, and they cannot pay their bills, their creditors will find that out as soon as anybody, and they must gradually drop out of the field. We have in Philadelphia one inspector who has done all the good work that has been done there. He works by common sense, and that he is pretty near right I do not think requires any better proof than the fact of the little trouble we have had up to this time.

Mr. Marsden J. Perry, of Providence, R. I.—One very strong point has been brought out by Mr. Smith, and that is, that the combined insurance interest, rich in its aggregate capital of hundreds of millions of dollars, requires to have the hat passed around to the tune of two cents to each lamp; that is a fact I am very glad to learn, and I shall take it back to my people with a great deal of satisfaction. You appointed a committee a year ago, of which I had the honor to be a member. Its report has been before you for discussion. If we go on forming exchanges and working down through school districts and up through counties and states and finally have this grand national insurance exchange, we shall have a grand institution; but what will become of the wiring and the general progress of the business while we are waiting for that consummation? If one year ago, when this committee was appointed, you had simply recommended to the insurance companies that they send their inspectors to first-class, reputable electrical engineers, and they had spent one week in conference with those gentlemen inspecting the installations in almost any town, at the end of that time or a fortnight they would have had sufficient knowledge to enable them to inspect decently almost any ordinary installation, and the whole thing would have been settled. That is where it must come finally, and we might as well begin at that point as to spend a year getting there. There exists no necessity whatever for this grand and intricate organization. Why should our business be made a special exemption from the ordinary routine by which such matters are accomplished? There is no mystery about the carrying capacity of a wire. For one cent you can buy a set of tables which any mechanical engineer will endorse as being perfectly safe to follow. It is a very simple matter, and it is a matter that rests entirely with the insurance company finally to say that they will or will not accept the installation. The question of poor workmanship will be settled by that very definitely. When a man or a construction company has made a bid so low that it is necessary to put in inferior work to protect against absolute loss, and the work has been rejected by the insurance inspector, and the man with whom he has contracted has thereby been given a just reason for refusing to pay the bill, and he is obliged to reconstruct it and make it meet the demands of safety, there will be no trouble; he will not repeat the dose. I do not believe that there is the slightest necessity for going into this work at all. I think that this convention should carry out to a great extent what we have recommended in the reports. The insurance inspector who steps into a building and is competent to inspect everything in it except electric wires, should make himself competent to inspect that risk and accept or reject it for cause.

Mr. E. A. Armstrong, of Camden, N. J.—I do not believe that this convention ought to employ an instructor of insurance inspectors. If we are to go into the business of employing schoolmasters for the populace, the first thing we will have to do is to employ a schoolmaster to go to Ohio. I saw in a paper here that a member of the legislature of that state had introduced a bill requiring all the dangerous electric wires to be buried throughout the whole state, and yet confessed in introducing the bill that he had never seen an electric light wire or an electric light until four weeks ago when he went to Columbus to be sworn in as a member of the legislature. I am sorry to have to admit it, for the sake of the argument, and I trust it may not be held against me, but I have been a member of a state legislature and I know something of the wisdom and intelligence of state legislatures, and if it is proposed by the aggregation of the electric light companies of the United States to endeavor to instruct men in what they ought to know, and in what they pretend that they are competent to do, we might as well surrender to them at once our whole plant and go out of the business. The insurance companies are to insure us, and as Mr. Smith well said, "I think they will very readily and speedily find means to ascertain whether or not the work that is done is properly done." I happened to be the president of a company that had constructed a hotel within about thirty miles of Philadelphia. We gave the contract to the lowest bidder, and so we ought to do. The insurance companies sent their inspector to see the work, and the work was condemned. We have not paid for it. We immediately notified him that we would not accept his work and gave the contract to some one else; the insurance companies did that. We do not propose paying for this inspection; they are the ones to do the inspection and tell us whether the work is done satisfactorily or not. I am president of an electric light company. I do not propose to have my company either inspect or pay for the inspection of buildings; we will furnish them the light; they are to ascertain for themselves, or the people who underwrite them, whether the work has been done properly. Let the insurance companies look to that.

Now, as to the recommendation of mutual insurance companies for electric lighting, I should be very sorry to see this convention advocate the establishment of a company to manufacture wires or a company to manufacture dynamos or a company to manufacture lamps or switches, because, as an electric light company's officer, I want to get the best at the cheapest possible cost to my company, and I do not propose to start something myself or in connection with other electric light men to beat down prices. I have one branch of business, and while mutual insurance companies are a great benefit sometimes, yet I feel that this convention would be making almost a fatal mistake if it adopted this report as it stands, recommending the institution of a mutual insurance company. Let us see ourselves that our work so far as our plant is concerned, is done with regard to our own safety and then we may rest assured, as Mr. Perry said, that this great aggregation of millions of capital in the insurance companies will furnish to us insurance and underwrite us much cheaper than we can do it ourselves; so do not let us adopt that part of the report.

Mr. Perry, of Providence—My remark relating to insurance companies applies specifically to wiring done outside of our stations; but I do unreservedly want to put myself on record as indorsing the plan for a mutual insurance company for central stations.

Mr. Alexander—New Jersey, as you all know, is different from any other state in the country, and therefore the insurance men there may be entirely different from the insurance men in other states; but we in New England have found that insurance men refuse to insure us. Now, what are you going to do about it? Are you going to go without insurance because you think they are wronging you? No. They do not know anything about electric light. I do not blame them. They think it is dangerous. They say, "We are writing an ill-understood risk, and we ought not to be put to the expense of providing a competent authority to ascertain how to estimate this new risk." They talk very fairly about it. When they find the risk a good one, they reduce the rate, and to-day every building in Taunton that is lighted by electricity has a reduction of ten cents on its insurance rates. I believe the money paid by the lighting companies is flowing back into their pockets; their business has increased rapidly on account of the good inspection.

Mr. S. E. Barton, of Boston—I was much interested in the remark of the gentleman from New Jersey, but he evidently does not know what is going on in the United States. I have been an insurance inspector myself for fifteen years. I would not consider myself competent to be an inspector to-day; I would not consider myself an insurance inspector in all that that term implies if I did not consider myself competent to inspect an electrical installation as well as a gas installation, and that is the very point that we are hammering at in the report of this committee. Now we have had the industry of electrical lighting going on in this country ten years or more, and to-day out of nearly one thousand inspectors employed by insurance companies in this country I do not believe you will find two of them that pretend to know anything about the inspection of electrical apparatus. Why is this? Simply because they have let that alone as a subject too deep for them and left it to work out its own salvation, and in letting it work out its own salvation you have made the mistake. Installations all over the country abound with errors that are incident to first construction; things that could not be avoided, but things that can be avoided and remedied in the future. Good inspection you say is what you want; you don't want to pay for it, but you cannot get anything in this beloved country unless you pay for it, or give an equivalent in some way. Now we have examined this matter, and we have taken the position that the man to inspect the insurance business is the insurance inspector who inspects every other hazard. He is not competent to do it to-day. You yourselves who have been in the business all these years know that he cannot be competent to do it without more instruction. He cannot qualify himself in a day; he cannot qualify himself in a year without an instructor. Now we have taken the stand and hold to the proposition that it is wise for the electric lighting people, not this association, but the electric lighting people throughout the country, to put their hands into their pockets and say to the insurance fraternity, "We will provide the instructors, not to instruct the people of the country *and* the legislators—that would be a hopeless task,—but to instruct the insurance inspectors in what is necessary to qualify them in their inspection." By the appointment of a sufficient number of instructors you could furnish object lessons to these insurance inspectors, show them what is necessary when they have to discriminate between good and bad work by showing the good and the bad to them. This committee was appointed, not to point out what ought to be done, or what are the rights of the electrical people and what are the duties of the insurance people, but its very name tells what it is for; it is to harmonize the interests of the insurance and the electric lighting people; and the way we believe they can be harmonized is by conceding on the part of the electric lighting people in the first place so many dollars and cents, to be paid out by the insurance people to the end that at a given time, giving them fair notice in the beginning, they are expected to have their men qualified and competent to do it, and take my word for it they will be so. In Philadelphia, as Mr. Smith says, they are doing good work, but they are doing simply what we have been doing in New England for years, and they are reaping the benefits of it. They are getting lower rates of insurance on properties lighted exclusively by electric lights than by any other class, and the insurance side is losing nothing by it. From my standpoint, as an insurance man, I wish every other kind of illumination was driven out, and that electric lighting was the only thing used. We would have a great many less fires. Now, then, I want to say a few words in relation to the project of an electrical mutual insurance company. I have had it in my mind for some time. If you will call to your minds one year ago, at Chicago, in speaking upon electrical lighting stations as fire hazards, I said that I believed the establishment ultimately of an electrical mutual insurance company, or something of that sort, would be the only solution to the question of insurance on central stations. I believe it more fully to-day. And I also said at that time that I believed that those few companies who are doing business in insuring electric lighting stations to-day, even in their deplorable condition, are making money. *Now* I know they are. It is not intended to antagonize the stock interest at all, but on the contrary to take in with it all those who want to come. Eight of them have manifested that desire, and a representation of the largest American company stated to me recently that it had been insuring electric light plants, central stations, for several years at nothing less than two per cent. They have made that the minimum rate and they have taken almost anything at two per cent., and have made money out of it. They have kept it to themselves; they now come forward and say they do not want to lose that class of business, but we want to come into this plan and take a share of it. A representative of one of the smallest companies in the country, a company which started a few years ago, told me that it took electric lighting stations simply because it wanted business and could not get anything else, and within two weeks he told me that its premiums in two years were over $60,000 and their losses less than $300 on electric lighting central stations.

I want to say a few words in relation to the examination and licensing of men employed in electric lighting installations, the work being done by the New England Electric Exchange. I cannot agree with my friend Mr. Smith, that that method does not give a guaranty of the character of the man. On the other hand, that is one of the important features of it. It examines him technically first; it then considers his moral aspect, and not a license is issued until it has been laid before and countersigned by the man who knows him personally and knows his habits and everything pertaining to him better than anybody else, and that is the inspector of the New England Insurance Exchange. Every license has to go before him, and receive his countersign, and thereby the exchange has the guaranty that that man is all right in every respect. I know it is so, because I know that more than one man has not received a license simply because he did not meet the requirements in that one particular phase while he did meet them in other points. Now, Mr. Smith says we do not need rules for the installation of electric lighting apparatus. I can hardly agree with him there. I myself feel that the rules that we have in New England are on the wrong tack, that if those rules were turned around, and instead of saying what *should* be done in the line of safety, they said, what should *not* be done, it would be more in accordance with my ideas. But we could not start that way. We did not know in the beginning what should not be done. We knew in a crude way what should be done; we have gone on, and from time to time, through experience, we have added to those rules until they are complicated, and cover a great deal, not of ground, but of paper, and I believe, as Mr. Cutter said in the beginning, that it would be to the advantage of the electric lighting industry all over the country, if some sort of committee could be formed to draft a set of rules. It could be made a standing committee whose duty it should be to consider and revise the rules from time to time; then we would have some rules that would obtain not only in New England, but in California, and even in Chicago. When we first started the method of examination in New England we had a different inspector for each locality, one at Boston, and one at Portland, New Haven, Springfield and Providence. What was the result? A party installing a plant in Maine was subjected to one set of rules; when he went to New Haven or Providence or anywhere else, he had to conform to a different set of rules. We ought to have some general rules, so that the party installing in New England would meet the same rules when he went to any other part of the country. I would like to see a committee appointed for that purpose, and I would like to have a good part of that committee made up of insurance men, who are the only men who can enforce any rules you make. I would have a certain number of practical electrical experts on the committee, and these men could be selected—one or two by this association, and one or two by your sister Edison association—and let the committee be large enough to cover the entire country and small enough not to be cumbersome, and let it govern the question of rules and let those rules be condensed and solidified and brought right down to what is useful for safety, and then have the rules so framed that the insurance inspector—who can tell you all about everything except electricity—can understand them. Going back to the subject of mutual insurance, I want to impress upon you the importance of the fact that the inspectors of your mutual insurance company will be excellently qualified to give valuable ideas to the insurance companies. The company will break down all the barriers of prejudice; it will show to the country that you are not afraid to insure your own plants, that they are not those terribly hazardous fire generating establishments that they are commonly understood to be. I hope that the recommendations of the committee will prevail.

President Weeks—We have with us Captain Brophy, of Boston, of whom we have all heard much and from whom I am quite certain we would like to hear more on this occasion.

Captain William Brophy—I am pleased, as one who has no pecuniary interest in any electric lighting company, to have the privilege of saying a few words. I began with the New England Exchange four years ago to examine the work done by electrical people, and am happy to say that I have had the hearty co-operation of all engaged in that business. The insurance people were ignorant of this new element introduced into buildings, and naturally were wary of it; they felt that it was not their duty to maintain this inspection, as all their risks were insured and rated before electric light was introduced. So they made arrangements with the electric light companies to bear a large portion of that expense. To-day more than one of them have testified to me that the expenditure thus made has been returned a hundred fold. We have been exempt from injury to life and person in a remarkable degree. The few accidents that occurred were purely on account of the negligence and recklessness of the unfortunate victims. Our losses from fire have been so small that they are hardly worth noting. I wish to state here emphatically that the report made by the worthy fire marshal of the city of Boston to the board of aldermen that in his belief the disastrous fire of Thanksgiving Day was due to electric wires, was made without due deliberation and with a wonderful lack of necessary information. Anyone who knows anything about the condition of affairs there, must know that that was not the cause of that fire. I certainly do, and if I had any respect for the electrical knowledge of the worthy fire marshal of the city of Boston previous to his report, I have since lost it. We have had since the organization of the exchange a set of men employed in construction work that in point of intelligence and knowledge of their business cannot be excelled in this country. The time is fast approaching when the duties of the inspector must cease in New England unless he wishes to be a pensioner upon the bounty of the electric light fraternity, and he has not reached that age as yet. This is owing to the hearty co-operation of the men engaged in the electric lighting business in New England. As I have stated to our executive board only a day or two before I came here, the work is now done so much better than when we began, that in many cases the duty of the inspector is simply a matter of routine; we have arrived at that happy stage by a rigorous inspection, by rejecting every piece of poor work that we could find, by impressing on the minds of those engaged in construction work the futility of attempting to palm off anything that was not first-class, and in all this work we have not been obstructed in the least by the men most interested—the electric light companies and construction companies. There is a prejudice in the minds of the people that never should exist. Many people believe that death is present in every foot of electric wire. Many people believe that when it is introduced into their buildings their property is liable at any time to be destroyed by fire. There is no just reason why this should be believed. The men engaged in the electric lighting business in New England are as honest and as unwilling to hazard the lives and property of any of their customers as they would be to imperil their own, and the feeling in the minds of the public has been created largely by the sensational press. It is unjust that electric light men should be subjected to such an outrageous raid on their business by the press of this country, by men who write articles, but do not know the technical difference between a wheelbarrow and a dynamo.

Mr. T. C. Smith said that many fires are attributed at once to electric lighting, when if the building had been properly inspected the accident would not have occurred. In one case Mr. McDavitt, of Philadelphia, went into a mill the proprietor of which was in the state of mind that the public generally is, and thought he was liable to burn out at any moment. The first thing that he saw was a large bundle of greasy waste, and he said, "You are in more danger from that pile of waste in one day than you would be from electric lights in ten years."

Mr. E. H. Williams, of Cincinnati, spoke in favor of the report of the committee from the point of view of a shareholder in insurance companies. He thought highly of the proposal to found a mutual electric insurance company.

The organization of state associations seemed to be in the direction of harmonizing insurance and electric interests. The committee should have before them, also, the question of deciding upon the value of the various safety devices now offered. We want rules; but they should be as simple as possible and be clearly understood. His companies would be glad to aid in the organization of the electrical mutual. They will furnish the result of their inspections and will endeavor to ascertain the dangers, and will expect electric light men to assist in avoiding those dangers.

The report of the committee was adopted.

The secretary then read a paper on "Construction of Central Stations," by Mr. C. J. H. Woodbury. (See page 98.)

DISCUSSION OF MR. WOODBURY'S PAPER.

Mr. M. J. Perry, of Providence, R. I. — I think I speak advisedly when I say that almost every central station man throughout the country finding his station too small has enlarged it to meet the requirements of all time, got it not quite completed, and then found it was still too small. I think we have rebuilt three times but the last time we determined to settle that matter for a considerable period, so we bought a plot of ground 200 x 300, covered it about half, so that we could easily handle 4,000 lights in our city. We find now we must just duplicate that.

The one important point is to determine how large to build the station that it may serve its purpose for not less than 25 years. One of the ideas that suggested itself to me was to take the total gas output of the city, and on the basis of 16-candle lamps reduce it to steam power and provide for from two to three times the total gas output. Buy your land now for the buildings you will erect in the future, and you will find it much cheaper. So far as we know to-day, we have got to rely on steam power. Locate your boiler with reference to the whole plot of land. Make arrangements with your engine in the same way. Then put in your first ones and follow that plan out. When you have determined by the rule of taking your gas output, divide your power into about ten units; ten engines.

As to what engine to recommend, I do not believe that I shall attempt to offer any suggestion. We decided to adopt, and have erected, a triple expansion engine built by Allis & Company, of Milwaukee. We have had it in operation now for about four months, and we have never had the slightest trouble with it. It has done admirable service, and although it has not yet been tested, it gives great promise.

When you set about constructing your station, it should be of a permanent character, and there should be made very large and liberal arrangements for the growth of your business. If that is neglected, there will be the universal inconvenience which has already been suffered from starting up in a hen-roost or under a shed outside. I believe the loss of money in this direction is greater than in any other in central station experience. The fact is, the day has gone by for that sort of thing.

The strong point I wish to bring out is the providing of ample space or ground. Buy it and own it. It is what you want for future growth and development. That is certainly a pertinent lesson that has been taught us by the universal experience of all men engaged in central station construction.

Mr. M. J. Francisco—I would like to ask the speaker if he recommends independent condensers?

Mr. Perry—We had designed for our station an independent condenser operated by an independent engine, and it had some unusual features. It is the first cut-off cylinder that was ever put on a condenser that I know of. We have been operating with that since about the middle of December, and it has been very satisfactory. We have a guaranty as to the steam or water consumed in developing a certain amount of power, so that it is to be brought down to the same level of economy as the main engine. The condenser which we are operating is a condenser designed to handle easily 2,000 h. p. Our first engine is in, and we have worked it up to 750 h. p., and have never had a minute's uneasiness. It has never been shut down an instant. It has operated so satisfactorily that we have now contracted with the builders, and they are at present constructing for us another engine of the same stroke, the same diameter of fly-wheel, and intended to drive on the same shafting up to 1,500 h. p.

Mr. Fred E. Sickles, the veteran inventor, then read an extremely interesting paper on "The Steam Engine."

After giving a valuable discussion of engine design and construction, Mr. Sickles said :—

"In regard to the steam engine of the future, if a metal is found that will enable steam of, say 1,000 degrees to be used, and the escaping heat from the first boiler to be used in evaporating water to feed a second engine at 500 degrees, and then to a third engine that will make the draft by drawing the heated products of combustion through water whose evaporation will supply a working cylinder that derives its power by receiving the steam below the atmospheric pressure and expands it to the lowest effective limit before discharging into a condenser—then we will have a combination using much less water per horse-power than any engine yet made; but it does not follow that such an engine will be the most economical, as that will depend upon the interest charged for the use of money and the price of fuel, as it would cost more per horse-power to build such an engine than one working under ordinary conditions. With money at 6 per cent. per annum and the cost of fuel to evaporate one ton of water at $1, a certain plan would be advisable. Again, with the money at 3 per cent. per annum and the cost of fuel to evaporate one ton of water at 50 cents, the same plan would be good, but as the cost of money and the cost of evaporating water change relatively, the best plan for economy in a steam engine would necessarily change to obtain the most economical result in the use of money. The cost of room for the plant and the cost of water for condensation, together with other contingencies, must be considered in any plan for a steam engine that is to be adapted to the surrounding circumstances under which it may be required to work."

THURSDAY, FEBRUARY 13—MORNING SESSION.

Mr. George H. Babcock's paper "On the Economical Generation of Steam for Light Stations," was read by George E. Palmer.

Mr. Babcock's paper, which was full of suggestion and caution for constructing engineers, contractors and lighting companies, was happily summed up at the end, by the writer, as follows :—

First. The use of the fuel which gives the best results for the least money. This varies with the locality.

Second. A furnace which will burn the said fuel to the best advantage, and at the same time permit of the rate of combustion to be quickly changed to meet the greatly varying demands without serious loss of economy between the highest and the lowest.

Third. A boiler which will utilize the heat to best advantage; which will give dry steam; which will permit of being forced much above its average rating for short times, without serious loss of economy; which is safe against destructive explosions, and which is not liable to frequent, difficult or costly repairs.

Fourth. Foreman and firemen with brains enough to employ all these things to the best advantage, and keep the apparatus at a point of maximum efficiency.

In selecting these elements of an economical plant it is urged that the co-efficient of common sense should be fully employed, and that facts gained from long experience are a far safer reliance than mere assertions not backed by years of practical results.

DISCUSSION ON THE PAPERS OF MESSRS. WOODBURY, SICKLES AND BABCOCK.

Mr. F. E. Sickles spoke in commendation of several points in Mr. Babcock's paper, particularly approving the provision of boilers that could be forced to extra duty for short periods without injury.

Mr. T. Carpenter Smith also approved the same point made by Mr. Babcock. If you can force your boilers during these two or three hours, by keeping the fires clean and being ready for the heavy load when it comes, you not only save the cost of a surplus boiler plant, but you save very largely in fuel consumption. He knew of a station where the fuel consumption was increased 50 per cent. by the necessity of having to fire up the second boiler for the two or three heavy hours' duty between four and eight o'clock. He knew there was strong prejudice against forcing boilers on the score of danger, but did not think any electric light station should be run by a man that could not be trusted to force a boiler without endangering it.

Mr. C. J. Field, of Brooklyn, N. Y.—I do not think we ought to pass over Mr. Woodbury's paper submitted yesterday, without looking at it a little more carefully. We all know what Mr. Woodbury has done in New England mill construction, which in the last few years has done more to bring up the standard of buildings of that class and make them safer against fire, than any other class of construction in the country. And when we see that these principles can be applied to small station construction, I think they are such as the electric light companies ought to know and give attention to.

Mr. M. D. Law—Mr. Woodbury has given us an explanation of a baby station. It is of hardly sufficient size for even a country town. In our experience it is far better to build a two-story station, having your dynamos on the upper floor, in order that there shall be no posts or wires projecting up from dynamos to interfere with the rapid moving of machines from one portion of the room to another, or the changing of armatures. As the continuity of your lights is the criterion of your success, you want to have your machines in such shape that an armature can be rapidly changed, and also that if the machine flashes that the dynamo man can get there quickly, and that that machine may not flash the second time. Flashes mean rebates, and they are very expensive.

Mr. S. E. Barton—I believe that more than three-fourths of the fires that have occurred in stations have been due to carelessness, to want of cleanliness. I believe further that a thing that is very sadly overlooked in the care of central stations is the condition of oil aside from the waste itself. A large amount of oil is allowed to accumulate on the station floors about engines and dynamos, so that when once a fire occurs from any cause whatever, the material of the most inflammable nature is there to spread the fire in a perfect flash from one end of the station to the other. The air and floor are filled with volatile inflammable substances from the oil. I believe it is easy to keep the floor of a generating station as clean as a kitchen floor. I believe the floors should be made of hard-wood and should be kept free from oil by washing at least once a week, or twice a week, if necessary. We have any quantity of stations in that condition to-day, where you could scarcely soil a cambric handkerchief on the floor except from the coal that is tracked in. If a fire starts it can not make any headway. When a station is constructed as Mr. Woodbury designs, it would burn slowly. The keeping of a station clean by washing the floors in some instances can not be well and safely done with the present practice of running wires from dynamos down through the floor, for no purpose that I can conceive of, except for the purpose of bringing them up from the floor again. I know of no reason why wires can not go direct from the dynamo overhead in plain sight.

Mr. C. J. Field then read a paper on "Development of Generating Stations for Incandescent Light and Power." (See page 101.)

DISCUSSION OF MR. FIELD'S PAPER.

Mr. A. P. Seymour, of Syracuse—It seems to me, there is one rule that can be applied to all localities. That is the rule of using common sense which can be applied everywhere and under all conditions, to great advantage. Another rule that can be applied everywhere, is to do your work well. If you can't afford to do it well, don't do it at all.

In our station we are using Corliss engines. We used to use high speed engines, but we took them out and put in the Corliss engine, and we have found that our saving is about 52 per cent. in fuel. Of course we are in favor of the Corliss engine. Our conditions of course are different from those of an incandescent station.

Mr. Armstrong—Assume that we were only earning enough to pay our expenses. I suppose by the expenditure of a little more of that which Mr. Field has termed "variable expenses," that I could double receipts, and that seems reasonable. I could double my revenue, by an increase of say 25 per cent. in my expenses. If that is not so, then it seems to me, that electric lighting is rather a peculiar business. I am looking for the dollars and cents; that is what I am in the electric lighting business for. I am not a scientist. This association represents a great business, and, therefore, this point is something that we ought to have particularly cleared up. I am more pleased with this paper than anything I have heard here at the convention.

Mr. Field—If you increase your plant you of course get an additional income. I have assumed that increasing your outlay, your capital is going to increase proportionately, and that you will not add a debt on which you must pay interest.

Mr. Alexander—Mr. Field said that within five months they had but one cross which they blew out. I suppose he meant that they burned it out. I want to ask whether the third wire was grounded, and secondly, whether he considered it safe to blow out a cross? I think if you do that you increase the danger of electric lighting considerably.

Mr. Field—The question of grounding the neutral wire on a three-wire system, has not, I think, been thoroughly settled. But it is a thing that has to be left to the individual judgment of each manager. It varies in different systems. You strike some old systems where they practically have not grounded their neutral wire owing to defects in their underground system. They have done that to avoid a cross between their two outside wires.

As to blowing off the ground: When you get a heavy cross on your underground system, what are you going to do? You must shut down or blow it off. I do not think you are taking any great chances. I have seen a good many blown off, and I never knew them to give trouble. They will make the lights shake for a few minutes, and then you will go on serving your customers just as you did before, and take your time to hunt up the cross.

Mr. T. Carpenter Smith, of Philadelphia, then read a paper on "A System of Station Accounts." The paper was devoted to the description of a system of doing work and keeping cost, that could be used in stations of any size, and at the same time enable fair comparisons to be made between them.

Mr. Smith recommended a systematic division of duties between the officers, staff and employés, together with a simple, but comprehensive classification of orders and accounts such as would lead, in the counting-room, to a clear and easily intelligible record of the various departments of the service and the cost of operation under concurrent heads, useful for studying the progress of the business of a station, and for comparing its results with those of other stations.

The methods of administration and accounting set forth were substantially similar to those employed largely in corporations, adapted to the peculiar requirements of the business of electric lighting. The main principles are that no work should be permitted, or at least paid for, except upon written order from a proper official—and then all expenditures whatever should be charged to the account of definite orders; either standing orders or special orders.

At the conclusion of Mr. Smith's paper, the secretary stated that a letter had been sent to the association by Mr. Fred H. Whipple General Manager of the St. Louis Exposition company. Its purport was that the St. Louis Exposition company had requested the American Institute of Electrical Engineers, the National Electric Light association, and the electrical fraternity at large, each to appoint one of a committee of three to pass upon the awards of merit and the medals to be given at the St. Louis Exposition. Mr. Garratt said the American Institute of Electrical Engineers had named Professor Carl Hering as its representative on the committee. Mr. Edwin R. Weeks was then selected as the representative of the National Electric Light Association.

THURSDAY AFTERNOON'S PROCEEDINGS.

Mr. A. J. De Camp, of Philadelphia, addressed the association on the "Cost of Products to Central Stations."

Mr. De Camp explained the methods employed by his company in deducing the revenue per lamps and cost per lamp.

Having arrived at the cost of production, no man, he thought, could prosecute his business and take care of it without being familiar with the various items of which that cost is made up. He saw fit to divide that under, first, pay roll; second, general expenses; third, taxes; fourth, interest; fifth, extraordinary; sixth, coal; seventh, carbon; eighth, engines (repairs and maintenance); ninth, dynamo; tenth, lamps; eleventh, lines. He divided the pay rolls into three classes. First, the electrical department; second, the motive power department; third, office pay roll. The general expense was grouped into stationery, carriage (express—freight—horses), tools, and miscellaneous items.

He thought it a mistake to assume that income from increase in business so far outstrips increase in the cost of production. In a respectably sized station, suppose that an increase of from 600 lights to 800 is made, and results in an increase in cost of 10 per cent.; an increase of 25 per cent., that is, from 800 to 1,000, results in an increase of 8 per cent. in cost; an increase again of 20 per cent. results in an increased cost of 7 per cent.

DISCUSSION ON STATION ACCOUNTS.

Mr. Francisco—I consider this matter of central station accounts as one of the most important subjects that a central station man has to deal with. During the past year I traveled from Boston to Washington Territory, and as far south as this city, taking in nearly all the stations, numbering several hundred. In the course of interviews with the station men I found that a large number, in fact the greater portion of the ordinary stations, small stations, kept no classified accounts whatever. They run plants, their engines and lights, and at the end of the year struck a balance. In a great many cases they found the balance on the wrong side, but they could not tell where it went to. If the central station men will adopt Mr. Smith's plan of accounts throughout the United States, it will be of great assistance. There are some of us who may not want to give away our secrets, but if I find one man whose lights are costing him a certain amount of money, while mine are costing a good deal more, he will afford me an explanation, and give me the benefit of his experience. If you do not keep track of your expenses in those things, they will eat you up.

Mr. Field—The stations which I have taken my basis from have been incandescent stations, while the stations Mr. De Camp has referred to are arc light stations. That will explain much of the apparent difference in the results. Mr. De Camp doesn't say where on his list he gets his fixed expenses and his variable expenses.

There is one company that receives reports from 100 or 200 of its central stations, not of details, but of general expenses, operating expenses and earnings, and publishes them each month for the benefit of their other stations. From this it will be seen that one station is using so much coal, and producing a given result. Of course there are local conditions. One place gets coal at 10 cents per ton, and another pays $5 per ton, and these are things that must be taken into consideration. But when you take into consideration all these things, you get a result that will show where your mistakes are, show where your men are not doing right, and point out the remedy.

In regard to the proportion of variable and fixed expenses, I will say, that since this morning I have been looking up a few facts and data, and I find one large station is down as low in variable expenses as 21 per cent. of the total expenses. In other words, that station has doubled its business, and has only increased its expenses 21 per cent.

Mr. T. Carpenter Smith—I have been asked several times how to handle the depreciation account. I do not know of any better way of doing that than by having no extraordinary account, but one repair account; the repairs cost so much from year to year. The fact that we have had a smash-up and that repairs cost us a little more for one particular month ought not to have any effect with the directors when it was explained. But if at the end of the year it would appear they were too much, they should be looked into. We should want to keep our account near the point which was settled upon as about the true basis. That is to say, every time there is put in a new engine, or a new dynamo, or a new boiler as an addition, it should be charged to construction account. But when you find that the engine is worn out, and you want to change it, you charge the new engine to repairs and sell your old one for what it will bring. The only increase in your capital account are your legitimate construction expenses. It is the same in a pole line. If a new pole goes in where there was a pole before, that is charged to repairs.

President Weeks—If you will pardon me, Mr. Smith, what do you do if there is a change in the market value of material?

Mr. Smith—That you will have to charge to repairs the same way. You will get the benefit of the cost when you put in a new machine.

President Weeks—We can all remember when a sewing machine cost from $100 to $150, while we can now buy them at from $10 to $30. Will not the same be true, to a considerable extent, with regard to electrical apparatus? What will you do with that shrinkage?

Mr. Smith—If you bought a dynamo for $1,000, the first year it is worth $1,000. Every year your dynamo decreases in value; it gets worn out. When you get your new dynamo in, you get it for less money. Your capital account remains the same. You have otherwise to make a gradual drop in the value of your plant in making your annual statement. I want to get rid of the depreciation account by making it all repairs.

Mr. De Camp—A rule which, I think, is a good one in this depreciation account is this. The depreciation account is an unknown quantity; it is a conservative way of guessing at things or keeping account. A rule like this will always enable you to be on the safe side. Merely incidental repairs are not things, that affect it one way or the other. But when it comes to the general repairs, and you work on this principle, if after these repairs are made, is your engine or your dynamo or your boiler as good as new? Then your construction account is not affected. Overlook all charges or all depreciations, if not connected with any general expenditure of money.

Mr. Smith — I would explain, in speaking of the capital account, that it is always a liability. In estimating your assets, it would be a simple way to keep these assets from year to year to put them in at the value for which you think they could be replaced.

Mr. F. A. Wyman, of Boston—My experience has been that this so-called construction account should be called a destruction account. This running of expenses into the construction account destroys or ruins more people than any other item in the business. It does not seem to me right to build a new station, run it ten years, let it pay 10 per cent. per annum, and at the end of ten years have to build it completely over again; so that your plant is only worth 50 cents on the dollar. It seems to me it is better to start out and pay a five per cent. dividend and charge the other five per cent. to depreciation. Of course, it takes courage to charge this up. A party making lights very cheaply, and having exclusive control of a city in which he is getting a high price, tries to make his operating expenses as large as they possibly can be made; but in a small town where there is only a small dynamo capacity, they try to make their construction account as large as it can be. You have to steer between the two. I wanted to give you a practical illustration. About 20 years ago there was a gas plant started in a good-sized town in the east with $100,000 capital. The other day in looking it up, we found they had a paid-in capital of $85,000. They had $35,000 worth of property left. The other $65,000 had been paid away in dividends. They hadn't kept any depreciation account; it all went into the construction account.

Mr. J. J. Burleigh, of Camden, N. J.—I think there should be no such an account as a depreciation account. In arriving at that calculation I was interested in watching the plan of the Pennsylvania Railroad Co., who have given a great deal of attention to accounts and the best plan of arriving at values, and they do not have any depreciation account. They aim to keep their road and its equipment up to the standard all the time, and charge it to expense. Anything new that aids their railroad is charged to capital, and that which replaces what is worn out is charged to expenses. Take the case of a locomotive which is valued as scrap at perhaps $1,000. That is replaced with a new engine costing $8,000; which is charged to expenses. They know exactly what they have got; and so can we know. They want to know whether they have a railroad worth what they have it capitalized for. We want to know the same thing. They have to take an account of stock, just as we do. They know just what the value of their railroad is. We are so particular in our company in Camden that we have everything in that direction go to expense. If we find by an account of stock that the values of what we have on hand are not what we are capitalized for, the board takes action and charges it to expense.

Mr. J. E. Lockwood—I believe the nearer we can know each month what we do, and not have to wait until the first of January or whatever date we take our inventory, the better we will be informed and the better we can carry out the improvements suggested by the results. I had a case in point in a company with which I was connected. We found just what the major part of our accounts was per month, such as coal and labor and accounts of that character, and we charged this into the total running expenses for that month. Then we found that the interest and taxes and accounts of that description, repairs included, varied very greatly. The interest and taxes it is true, we had to pay only once a year, but the repairs we studied over and arrived at this solution: We created what you might call a balancing sheet, and we estimated at the beginning of the year how much we would likely have to charge up during the year for taxes, insurance and accounts of that description, and then we started in and charged up each month in our monthly sheet what we thought was the proportion that that month would have to the total year. If we did not pay our taxes until the ninth month in the year, there was accumulated upon this balancing sheet during those nine months certain amounts, and we credited the same amounts in the monthly sheets as in the balancing sheet, and then taking the proportionate amount of that nine months we charged up the proper proportion in the remaining month. We adopted the same system for repairs. Instead of charging up each month just what the repairs were, we estimated as nearly as possible what they would amount to in each year, and then charged up one-twelfth of the amount we had estimated for the year, and as the end of the year drew near, we could see on our balancing sheet what was going to throw us out of our estimate. We divided it among the remaining months, and charged it up proportionately to each month in the year. I believe that in this way we will better know how to make improvements from our investigations.

Mr. G. M. Phelps, of New York, here read, for the information of the association, the following telegram which he had just received:—

"New York, Feb. 13, 1890.

"George M. Phelps,
"Coates House, Kansas City.

"Just returned from Richmond where bill for restriction of voltage in Virginia has been reported adversely by the unanimous vote of the senate committee after two days' argument. It was supported by Edison in person, and the electrical executioner; it was opposed by Westinghouse representatives, aided most efficiently by local companies at Norfolk, Alexandria, Petersburg, Lynchburg, Fredericksburg, Richmond, Liberty and others. R. W. POPE."

Mr. M. D. Law then read a paper entitled "Nine Years With the Arc Lamp." (See page 99.) This was followed by a paper on "Carbon Tests," by Mr. E. F. Peck, read by Col. C. N. Ransom, in the absence of the author.

DISCUSSION ON THE PAPERS OF MR. LAW AND MR. PECK.

Mr. Francisco—If it is not a secret of the business, I would like to ask Mr. Law with what instrument he tests grounds at the stations.

Mr. Law—I do not know that there is anything about our station that we call private. I have been testing grounds for the past year or eighteen months by the use of a set of incandescent lamps in series. I use 60 47-volt lamps for a 60-light arc circuit; these lamps are put up out of the way and a wire run from each to the switch plate. There is a lever arranged to turn in a circle making a short circuit of one, two, three, four, five, etc., to cut-out one or all of these lamps. Now, if a ground occurs from the station it is simply a measure of potentials. Every two hours we test each one of our circuits, first testing across the circuit. The number of incandescent lamps then burning up to 47 volts, indicates the number of lamps that are actually burning on the circuit, less the resistance of line; then we test by placing one side of the incandescent circuit to ground and the other side to line; then by turning off my incandescent lights until I bring the voltage up to 47, I find a certain number of lamps burning. We will say 10 lamps on the positive side; now I turn my attention to the negative side and go through the same operation. If I find that I have 50 lamps on the negative side, I know that the ground is 10 arc lamps away from the station on the positive side, and if your circuit books and diagram books are correctly kept, you can tell in two or three minutes exactly the location of that lamp. In 99 times out of 100 we go to the right lamp.

Mr. DeCamp—In Mr. Peck's paper he speaks of an arc lamp being burned at the Centennial in 1876. I will ask if any gentleman present saw that light? I was at the Centennial probably a hundred times and never saw it.

Mr. Garratt—I did not see the lamp at the Centennial, but as a matter of early history in regard to the arc light industry in this country, I did see an arc lamp run in Boston, in 1865; that, however, was not to be called commercial in the sense in which you use it to-day. It was an arc lamp with clockwork feed.

Mr. Lockwood—While I did not see any lamp at the Centennial, I will state that Frauk B. Rae, of Detroit, will give Mr. De Camp the information he wants. My reason for thinking so, is that Mr. Rae gave me not long ago an account of an interesting experiment he made at the Centennial. He found that by making a flat helix of fine wire and connecting it with the receiver of a telephone, he could approach a dynamo and before he got within, say five or six feet, and sometimes 15 or 20, by holding it out ahead of him, and moving it through the air, he would get induction, and then by comparing that with the tones of a flute that he had attuned to respond to a certain number of vibrations, he could tell the number of revolutions the dynamo was making by multiplying by the commutator sections.

Mr. F. S. Terry, of Chicago—I will say that I saw that lamp in Philadelphia.

Mr. H. W. Pope's paper on "How Our Paths May be Made Paths of Peace." (See page ——), having been printed and distributed, was taken as read.

The paper of Professor Elihu Thomson on "Safety and Safety Devices in Electric Installations" (see page 95), also printed and distributed, was taken as read.

DISCUSSION ON SAFETY DEVICES.

Mr. Lockwood—I am sure that every member of this convention must feel in the present condition of electric lighting the need of safety devices. I do not want to be understood that I am now using in my station every device that I advocate; but they will all go in with the greatest possible despatch that I can get them in, and do the work thoroughly; then I am going to keep our station in the matter of safety devices at the head of the list as far as lies in my power.

Professor Thomson speaks of the fact that the dealing with the wire question by the authorities in New York city has been very severe, but yet thinks it will lead to final benefit to the electrical interests. I think that depends upon no one thing more than on how we keep our circuits supplied with safety devices from this time forth. I think if we do not pay great attention to adopting means for denoting a ground when it occurs on a circuit and then locating it and finding how it can be removed in the shortest possible time, and seeing that in all ways they are kept clear and free, we will not have the success that we ought to have.

Mr. Law—In lightning arresters I think we have a very important species of safety device. Not only do they protect the dynamos, but they protect the insurance companies against loss by fire. Before the adoption of lightning arresters in Philadelphia, we had three fires in buildings which were caused by lightning coming in on our lines; but since the introduction of lightning arresters we have lost no dynamos and have had no fires. Another important feature of lightning arresters is their protection to underground cables in taking up the so-called static discharge of the dynamo on the interruption of the circuit. The matter of cut-out boxes is another very important feature. They should be placed on every part of the circuit where it goes inside of a building or is attached to a building or a loop going over any street. It gives you perfect control of that circuit in case of fire. That was clearly demonstrated to me about two months ago at a fire in Philadelphia. I was at the fire very soon after the alarm, and found we had a loop going up in the rear of the building. I discovered there was no box upon that pole, for which my foreman received very severe censure.

Captain Brophy—I wish some one who had better control of the king's English than I, would do justice to the barbarous treatment the electrical fraternity has received at the hands of the so-called underground commission of New York. I agree with Professor Thomson in all he says in regard to that subject. A few men selected without any regard to their qualifications for the positions they hold, sit in judgment and throw a large city in total darkness without making any provision for any other form of light, and as it were, turn the whole city over to the hands of thugs and criminals. I believe myself that the insulation of overhead wires is only a question of dollars and cents saved to the parties who are operating the central station. I do not believe it solves the problem of preventing accidents to life and accidents by fire. An unused wire that no one cares about can drop down and saw its way through in half an hour, and some one will come along and complete the circuit from the wire to the ground and be the victim, and the press sends the news all over the land, giving no explanation of how or why it was done. So far as safety to the public is concerned, if you will run your wires well up in the air, if you can get the right of way to do so, it matters little whether they are bare or insulated. Until the municipalities or some other power will protect you from *tramp* wires, the poorly constructed wire, and the many other roads through which death and destruction may be carried, you cannot be held responsible for these accidents, and until you have the right and the clear right to run your wires without being menaced by such things as these, you cannot prevent accidents of this kind.

The secretary read the report of the committee on data as follows:—

REPORT OF THE COMMITTEE ON DATA.

The membership of the committee as now constituted is as follows: A. J. De Camp, C. R. Huntley, E. F. Peck, Edwin R. Weeks, Allen R. Foote. This committee has printed in pamphlet form and distributed to central station companies, the paper read at the tenth semi-annual convention of the association on "The Value of Economic Data to the Electrical Industry." Accompanying this pamphlet, a circular of inquiries was sent, inviting suggestions as to the items of data which those addressed considered desirable to be collected, also the forms of accounts, reports, which may be used to establish a uniform system of accounts with a view of rendering the data obtained from them reliable and valuable.

The responses received, by correspondence and personal interviews, leave no doubts in the minds of the committee as to the general appreciation of the value of the work to be undertaken and of the cordial co-operation of central station companies in carrying it to a successful consummation.

In view of the fact that the United States census office is now engaged in preparing schedules for obtaining certain data relating to the electrical industry, this committee thinks it best to suspend the work of formulating reports for the purpose of obtaining data until after the work of the census office shall have been officially published. The committee can then devise such reports as may be supplementary to, or a continuation of, the work done by the census office, thus increasing very greatly the value of the work it may do.

With the above object in view the committee has given special attention to the work of assisting the formulation of a special schedule for central station companies for the use of the census office. The outlines of this schedule have been submitted for suggestions to upward of thirty of the largest companies in the country. A representative of each company has gone over the entire subject in detail individually, and made such suggestions as seemed to him to be pertinent. The entire schedule is now in process of revision in the light of these suggestions. When this work is accomplished it will be again reviewed by this committee. In case the schedule as then submitted is satisfactory, this committee requests the authority of the association to approve of the schedule in the name of the association.

The first decade of the history of the electrical industry was necessarily the decade of theory and experiment. A decade in which large sums of money have been invested on the basis of representations made by manufacturers as to what their apparatus or construction was expected to do. During this period, the time of the conventions of this association has been largely consumed by long, and sometimes exciting discussions over this or that feature of the business in which all were engaged. No satisfactory solution has been reached by such discussions, because arguments were based on what was expected to be, instead of upon what was.

In entering upon the first year of the second decade of electrical history, it will be well for the association to draw a sharp line of demarkation and cease to discuss subjects from the standpoint of theory. It should substitute therefor the standpoint of facts. Not that the days of theory and experiment are over, that will never be. But the days are over when to have an electric service at all, it must be accepted on faith in promised results. The time has come when we can afford to wait for the adoption of a new idea, or new application of an old idea, until it has been put into practical use for sufficient time to enable their claims for general adoption to be based on accomplished results. Whose cause cannot be served by truth, should not be served.

Mr. Garratt called attention to the seventh clause of the report, and thought the phrase, "entering upon the first year of the second decade of electrical history," should be amended so as to read, "Electric light history." Electrical history ran back several centuries.

The report was adopted, and the committee continued.

INVESTIGATION OF ELECTRICAL INDUSTRY FOR THE CENSUS.

Mr. De Camp presented the following preamble and resolution:—

Whereas, The Superintendent of the United States Census has appointed a special agent for the investigation of manufactures of electrical apparatus and supplies and their uses; and,

Whereas, This is the first official investigation that has ever been made of this subject in this or any other country; and

Whereas, It is the opinion of this association that such an investigation will be of the very highest value as a means of furnishing the public with information that it can accept as being reliable, impartial and authoritative, and for that reason will be of great value to those interested in the electrical industry; and,

Whereas, This association, in behalf of the electrical industry of the United States, desires this investigation to be thorough and complete in every detail, and is aware that such an investigation could not have been fully authorized and provided for, on account of the newness of the industry, when the law providing for the census of 1890 was enacted—

Be it Resolved, by the National Electric Light Association, in convention assembled,

First.—That it respectfully petitions the Senate and House of Representatives of the United States Congress to authorize and direct the superintendent of census to collect the following data in relation to the electrical industry, in addition to the general statistics of manufactures already provided for by law:

(*a*) Details pertaining to underground and aerial construction, underground and aerial currents, the character and voltage of all currents, and their uses. Lamps in use, arc and incandescent, and how wired for residence, commercial and municipal service; motors in use for stationary service and motor cars; income and expenses, etc.

(*b*) An inquiry through sources independent of those interested in the industry, as to the casualties resulting from the use of electric currents, both as to fire and personal injuries; this investigation to be made in all cities of ten thousand population and over; the information to be obtained from underwriters, the records of fire departments, coroners' statistics, health boards or commissioners, or from whatever source of information that may exist in any city; the investigation to make a comparative statement between the casualties resulting from the use of electric currents, and the use of other agents employed for similar purposes.

Second.—That we hereby petition that an appropriation of not exceeding $50,000 be made for the purpose of this investigation.

Third.—That the National Electric Light Association hereby tenders its thanks to the Hon. Robert P. Porter, superintendent of census, for the recognition he has given to the importance of and wonderful progress made by the electrical industry, in the appointment of a special agent for its investigation, and we hereby pledge our cordial co-operation with the census office in its efforts to make the investigation thorough, reliable and complete in every detail.

Fourth.—That a copy of this preamble and resolutions be properly engrossed, officially signed by the president and secretary of the association, and transmitted to the chairman of the committees on census of the Senate and of the House of Representatives, and to Hon. Robert P. Porter, superintendent of census.

The resolution was adopted.

FREIGHT ON CARBONS.

Mr. Lawrence, of Cleveland, then offered a resolution, which was handed to the secretary.

Mr. F. A. Wyman, rose to the point of order that all resolutions should go to the executive committee and be approved by them before being presented to the association.

The president announced that the resolution was referred to the executive committee.

Mr. De Camp—On what rule of the constitution is that based? A resolution is presented, not read, and you announce that it is referred to the executive committee.

The President—It is based on the provision of the constitution that the executive committee shall arrange and provide for the programme and the order of exercises.

Dr. Mason—Have you given us the only authority for your decision?

President Weeks—That is the authority. There is in addition to that the fact that it is submitted by an associate member, and should come through an active member.

Dr. Mason—I understand that associate members have all the rights except those of voting, as recited in the constitution.

President Weeks—The decision of the chair is based upon the provision in the constitution. It is immaterial, however, if it meets with the concurrence of the convention.

Dr. Mason—I would be glad to have that matter decided by the association, through an appeal from the decision of the chair. I imply no disrespect in the appeal.

President Weeks—Certainly not. My ruling was on the way the matter presented itself to me.

Dr. Mason—I appeal from the decision of the chair. I think this question is a very important one and should be settled now. I do not think it was the intention of the association ever to repose in the executive committee such an exclusive power as this: that no business can get to this association except through the executive committee. If that is what is meant, let us know it.

President Weeks—I do not understand that to be so; but matters pertaining to the arrangement of programme and exercises—all such matters must come through the executive committee—as is distinctly stated by our constitution.

Dr. Mason—Of course we are all in the dark, I presume as to the character of this resolution, but I would like to have it decided whether a member of the association can present a resolution to the association direct, or whether it must go through the hands of the executive committee.

President Weeks—I think it can be presented directly to the association, if there is no interference with the order of business upon the table. There being no interference in this case, I think I will have to reconsider the position taken upon that. (Applause.)

Mr. Wyman—Mr. President. I rise to a question of privilege, and ask if it is not clearly stated in the constitution and by-laws that all papers and resolutions that are presented before the association shall pass through the hands of the executive committee?

President Weeks—It does not state all papers. I will ask the secretary to read that section of the constitution.

The Secretary—The constitution says that "the executive committee shall be the governing body of the association; that it shall meet upon the call of its chairman from time to time, and shall report upon application for membership, shall gather proper information upon topics of interest and see they are arranged for discussson by the several members of the association. Five members of the committee shall constitute a quorum."

Mr. De Camp—I may state that I have been a member of the executive committee, either direct or ex-officio, ever since I have been connected with the association. The executive committee have been in the habit of revising the papers which have been presented, for the purpose of relieving the association of the cumbersome amount of papers to be read for discussion before the convention. It has always been the case that there was more good material presented than it was possible for us to get through with; and, therefore, all such papers were referred to the executive committee to decide which were of the most general interest to the association.

Mr. Wyman—I would like to ask the gentleman who was last up if it was not the feeling at Niagara Falls that all things should go before the executive committee, in order that advertising schemes should not be thrown on the association.

Mr. De Camp—I presume if the resolution should take the form of an advertising scheme, the association is perfectly competent to sit down on it peremptorily.

Mr. Alexander—Mr. President, if an associate member appeals from the decision of the chair, how do you decide that point? Can an associate member appeal from the decision of the chair?

President Weeks—No, sir; I think not.

Dr. Mason—Does not the constitution recite that associate members shall have all privileges except those of voting.

President Weeks—An appeal from the decision of the chair, is a privilege so nearly akin to that of voting, that in my opinion it comes under that exception.

The matter was in fact presented by an active member. We will admit the resolution.

Mr. Wyman—I move the resolution be laid on the table.

Dr. Mason—That cannot be done until it is read.

Under the direction of the president, secretary Garratt read the resolution, which was as follows:

Whereas, The present classification of electric light carbons is much higher than other commodities of corresponding weight, bulk and liability to damage, packages less than car lots being rated as first class and carload lots as third-class; and this classification was made years ago when few carbons were manufactured, when they were high-priced and supposed to be very liable to damage, but are now among the cheapest shipped, are compactly and securely packed, easily handled, and not liable to damage in the ordinary risks of transportation, which is demonstrated by the fact that no claim for breakage of, or damage to, carbons has ever been preferred to the railroad.

Therefore. Be it resolved that the National Electric Light Association in convention assembled, considers the present classification unjustly burdensome, and believes the interests of all electric light companies will be promoted by reducing the classification, and that greater volume of traffic and corresponding gain to the railroad companies will accrue.

And be it further resolved. That this association indorses the efforts of the committee of carbon manufacturers appointed to make application to the general freight classification committees of the United States in furtherance of this resolution.

The resolution was adopted.

The following committee on nomination and place of meeting was appointed, Mr. Huntley, Mr. Francisco, Mr. Beck, Mr. De Camp and Mr. Beebe.

Mr. De Camp—I move you that when this convention adjourns that it adjourn to meet in the month of August, 1890, at such a day as the executive committee shall decide, at Cape May, New Jersey.

The motion was adopted.

FRIDAY, FEBRUARY 14—MORNING SESSION.

Mr. C. R. Huntley presented the report of the committee on nominations, as follows:—

President, M. J. Perry, of Providence, R. I,

First Vice-President, E. W. Maher, of Albany, N. Y.

Second Vice-President, C. L. Edgar, of Boston, Mass.

Executive Committee, C. R. Huntley, chairman; E. R. Weeks, Kansas City, Mo.; James English, New Haven, Conn.; S. A.

Armstrong, Camden, N. J.; M. D. Law, Philadelphia, Pa.; M. J. Francisco, Rutland, Vt.; A. F. Mason, Boston, Mass.; John A. Seeley, New York; H. K. Thurber, New York.

Dr. A. F. Mason—I desire, sir, in a word of explanation to make a nomination. I think that every member of this association recognizes, with something akin to gratitude the very felicitous, the very remarkable, services of the present president of the association. I believe that I do not speak for myself alone, but for every member, when I say that we have had an exceptionally profitable as well as enjoyable meeting here in Kansas City; and that very largely this is due to the efforts of our president, E. R. Weeks. I, therefore, desire to put in nomination, for the presidency of this association for the ensuing year, E. R. Weeks, of Kansas City.

Mr. De Camp, of Philadelphia—I arise to second the nomination. We certainly owe a proper appreciation to those who have already served us. I think I am justified in saying, of all the meetings that this association has held, there has been evidence of a healthy growth. But like the growth of our country, we have in that total growth made a stride. The step from our last meeting to the present, comes under that class. It is a stride! This is the most largely attended meeting that we have had. There has been the greatest interest taken in it, and our work has been of the most practical kind, and I think that it has been due very largely, if not entirely, to the efforts made by the president. He has been, during the last six months at work constantly, otherwise the results that we see could not have been accomplished. I would be glad to have him fully appreciate the feelings of this association.

President Weeks—Gentlemen, your action in this matter is gratifying to me, in that it evinces your approval of the administration just drawing to a close. Next to the consciousness of having done one's best comes the approval of one's friends and associates; but, gentlemen, my views of the presidency of this association have not changed. It is my opinion that the president of the National Electric Light Association should be a citizen of one of the larger eastern cities, one of the great electric centres, where he can carefully watch all movements affecting the interests of the industries that we represent. Kansas City is not such a centre, although Kansas City will sometime undoubtedly be just such a place and the place where, for this very reason, the president of some future convention of this association, might well be located; it is not so now. I have, during my administration frequently felt the disadvantage of distance; and if the interests represented in this association have not suffered, it has been due largely to the zeal and support of the eastern members; it has been due largely to the vigilance of our secretary and the earnest watchfulness, to the zealous application and industry of our executive committee. The success of this convention, gentlemen, which has been so kindly attributed to me, is due very much more to the combined efforts of those gentlemen who have supported the administration, and have looked out for the interests of the association so carefully.

For these reasons, gentlemen, I feel, much as I appreciate the honor that you offer me, that the best interests of the association require the election of the officers nominated by your committee. In the expression that has been made and in the increasing prosperity of the association, in the strengthening of it throughout the west, which was the reason for my acceptance of this office, I find my reward. I thank you, gentlemen, for your offer, but for the reasons stated, I must respectfully decline the nomination.

Mr. E. A. Armstrong stated that it would be unwise, both in justice to the duties of the position, and unwise from a personal standpoint, for him to accept a place on the executive committee. He suggested the name of Mr. Burleigh as a substitute.

A motion to substitute J. J. Burleigh in place of Mr. Armstrong on the executive committee was then put and unanimously carried.

On the motion of Mr. Phelps, the secretary was instructed to cast the ballot of the association for the officers and members named in the report as amended.

Mr. Frank J. Sprague, of New York, then read a paper on "Application of Electricity to Street Railways." (See page 105).

After a few commendatory words from Mr. Armstrong Mr. Sprague spoke in amplification of some points in his paper, among other good things, he said:—

There will be gradually in many of our cities an amalgamation of the electric light and railway interests. It seems to me that is the natural outcome, and I know that oftentimes the same stockholders are interested in both the electric light and railway companies. I am going to have very soon, in a little town in South Carolina, what I think is the most complete electrical station in the United States. Some associates and myself, being convinced that not only the electric light but the electric railway business was a good thing, from the experience we have had with it in the past two years, got hold of an electric lighting company that was earning a very reasonable dividend on its cost. The company had an electric railway franchise which was exclusive for thirty years, and which had been granted both by municipal and legislative action. It also had the general railroad privileges of condemning public and private property. The rights being exclusive not only in the two towns, but for the vicinity, for thirty years, and there being no railroad there, and there being established an electric light interest there, and there being no gas company, we thought the opportunity was an excellent one to carry out that idea which is always in the minds of electrical people, namely, the consolidating of electrical interests. We not only consolidate the electric part of it, but we consolidate the elements of management and personnel. We have different systems, the arc light system, the incandescent system, the power circuit and the railway circuit, all in the same building and under the same roof of the car sheds, and with all respect to the telephone interest, I think pretty soon we will have the telephone circuit. We are going to run telephone wires on the same poles with the others. We are going to demonstrate that it is quite possible to run a telephone circuit, an electric railway pole line not only in conjunction with it, but in conjunction with electric lights and incandescent lamps. We hope this enterprise will be profitable and that there may be a great many other places in which the same thing can be done.

Professor Eaton, of Liberty College—I would like to ask Mr. Sprague if he has any objection to stating what his principal reasons are for his conclusion that the storage battery system will not successfully compete with the overhead or direct wire system?

Mr. Sprague—It is this, the simple reason is that you cannot three times convert energy at the same economy that you can once. That is the first reason. Secondly, because you cannot carry a dead load of two tons around, unnecessarily, without energy—you cannot carry it around any way, necessarily or otherwise, without energy. You must carry your storage battery and you cannot get rid of that useless load. It weighs nearly two tons. It weighs as much as thirty-five or forty passengers. It weighs more than your motor equipment; it weighs more than your car body considered by itself; it weighs more than your iron trucks considered by themselves. We have to carry our motors around, we have to carry the trucks, the passengers, and the car bodies; but to carry our storage battery is another thing. There are no storage batteries in existence furthermore whose storage capacity will permit of more than 26 or 30 horse-power being taken out of it. If you limit the weight or size of your battery, you reduce its capacity. On grades of eight per cent., and that is about the maximum which the adhesion of the rail will permit, you find a great difficulty; you will use about 30 horse-power of mechanical energy, and the motor must develop that. There is no storage battery that you can put on a 16 foot grade to-day, out of which you can take that power for thirty minutes at a time; the capacity is not there. But when you get the overhead line or the underground conductor, provided it is connected with a big engine and a lot of dynamos at the other end, you can demand from that station all your motor can carry. There is no storage battery which a company dare recommend for operation upon a 6 per cent. grade, or that you could run 160, 170 or 180 miles a day. The maximum work of a storage battery per car, per day, is about 80 or possibly 90 miles, and there are very few cars doing that. There are no storage battery cars in the United States that I am aware of, that are working 18, 19 or 20 hours a day, as is the case with the direct system of supply.

I hope, as cordially as any other man can, that the storage battery is going to be a success; but there is no question that its limitations are pretty clearly fixed and that it can never compete with direct sources of supply in capacity. There is no limit to the capacity of the motor or the amount of current you can use from a direct source of supply. There is certainly a well defined narrow limit in the case of the storage battery. I say that with all friendliness to the storage battery, because I am interested financially in one—or rather I should say one is financially interested in me.

Mr. C. C. Haskins, of Chicago, then addressed the convention on the subject of "Prodigality in Economy," enforcing the still much needed lesson of liberal but wise expenditure as the only true way of establishing permanent economical conditions in electric plants, and illustrating his remarks by many telling examples of cheap work on the one hand and economical work on the other. The whole was well seasoned with racy anecdote and humorous suggestions, such as anybody looks for whenever Mr. Haskins takes the floor.

Mr. Charles A. Harber, of Kansas City, read a paper on "Line Insulation from the Standpoint of Practical Experience."

Mr. Harber said the question of the day for electrical industries was insulation, and that any information bearing thereon, derived from experience, might be valuable. He presented a brief record of measurements to determine the relative existence of several forms of insulation.

Among Mr. Harber's circuits, operating Thomson-Houston arc lamp (about 10 amperes at 50 volts) he had four varieties of insulation, viz:—P. & B., Simplex, Grimshaw and Okonite.

The external conditions of these circuits were nearly the same. The Okonite circuit in use 18 months, was 2½ miles long and operated 50 lamps; the P. & B. circuit in use 15 months, 2⅓ miles long, operated 40 lamps; the Grimshaw circuit in use 18 months, 2 1-15 miles long, 24 lamps; The Simplex circuit in use 13 months, was 3 7-10 miles long and operated 40 lamps.

During the 12 months ended January 1, 1890, measurements of insulation of these circuits had averaged: P. & B. 485,702 ohms;

Grimshaw 891,892 ohms ; Simplex 895,122 ohms ; Okonite 900,212 ohms.

Mr. J. E. Lockwood, of Detroit, then read a paper entitled : "How to Make Arc Light Circuits Safe." (See page 111.)

DISCUSSION.

Mr. Law—The explanation that I gave of testing for grounds is one of the first that has ever been presented to the association. It is a very good method, but still probably not as good as the one that you have just listened to. My reason for using a low voltage lamp was simply because it was easier to locate the ground, and it was easier for the men that were in charge of the station at that time to grasp the idea.

Captain Brophy—I believe any system of testing grounds on an arc light circuit, by a low resistance in the circuit of the ground is dangerous. The plumber and the gas-fitter, those worthy individuals who are a terror to all electric light men, get in their work, and an imperfect ground is established possibly between a gas pipe and an arc light circuit. It is desirable in testing to reduce the amount of current traveling over that part to the lowest possible amount. In addition to having a proper method of testing and clearing the line of the ground another very good thing to do is to clear your lines of everything in the shape of obstructions. There may be a wire run by a boy who has set up a bell somewhere, and whose fond parents believe he knows everything about electricity. Do not enter into any arrangement by which any grounded circuit can be run on your own poles and fixtures.

Mr. E. Gregory, of Chicago—We are running 300 arc lights. We have our chief linemen go over the circuits and see every foot at least once or twice a month. We use the galvanometer to take our measurements by. In that way out of seven circuits, for a period of over seven months, we have had no occasion to shut down for any line trouble. We haven't any newly devised schemes for locating grounds. Our circuits are all underground, running through alleyways. We have no air circuits at all, except where we come out of the alleyways. We come out and run into a building, and if it is only one or two numbers on the street we go right back into the alleyways. We think we have saved a good deal of money in that system.

Captain Brophy—I would like to speak upon one topic touched upon yesterday, and that is the desirability of some method of breaking the line without cutting it with an ax ; some method of disconnecting the lines in front of a building which is on fire, for the benefit of the fire department. There is no man who has studied up the sensational reports printed in regard to electric light matters so thoroughly as the average fireman. There is no man who dreads an electric wire more than he. After a wire is cut and let into the street though it be as dead as a door nail, he does not know it. If we had some method of disconnecting the lines from the dynamo by a system of switches, so firemen shall know the wires are perfectly harmless, it would be of great value to everybody interested.

Mr. Law—I can say that is practiced at the present time with us, and that every central station should send a competent man to every fire with the fire department. That has been done in Philadelphia now for nearly nine years. In some cases it has become necessary to shut down a complete circuit, where there was any danger of walls falling and breaking down the wires. I have provided in our fire wagon a cut-out which will hook over the wire, with steel pointed screws with a large wooden knob at the top, that a man can handle with perfect safety on any wire. Using that you do not have to cut away the insulation, but the point of the screw will penetrate through and make contact with the wire. Then by the use of properly insulated cutters a man can cut loose any wire that is liable to give trouble. We have done it in quite a number of cases in Philadelphia. We cut the wires so there is no possible danger to the firemen. The firemen understand this thoroughly. They know if they come to a fire in which a wire is passing in front of a building or into a building, as a rule, the foreman of the hook and ladder company will ask me if everything is all safe. A man is generally on duty who stays by the hook and ladder companies, so they know where to pick him up at any time. The firemen have orders from the chief of the department to allow any of the electric light people, to ride upon the apparatus if it becomes necessary to get to the fire quickly.

Secretary Garratt then read the report of the committee on state and municipal legislation, which was as follows :—

REPORT OF THE COMMITTEE ON STATE AND MUNICIPAL LEGISLATION.

For the sake of convenience and brevity, this committee recommends that its name be changed from "The National Committee on State and Municipal Legislation" to "National Committee on Legislation." The present membership of the committee is as follows :—Alabama, no member ; Arkansas, no member ; California, George H. Rowe ; Colorado, C. H. Smith ; Connecticut, John C. English ; Delaware, no member ; District of Columbia, Allen R. Foote (chairman) ; Florida, no member ; Georgia, H. E. Palmer ; Illinois, C. H. Wilmerding ; Indiana, John Caven ; Iowa, no member ; Kansas, L. A. Beebe ; Kentucky, no member ; Louisiana, no member ; Maine, Wm. R. Wood ; Maryland, J. F. Morrison ; Massachusetts, F. A. Gilbert ; Michigan, J. E. Lockwood ; Minnesota, no member ; Mississippi, no member ; Missouri, Joseph Corby ; Montana, no member ; Nebraska, no member ; Nevada, no member ; New Hampshire, Alonzo Elliott ; New Jersey, Henry W. Pope ; New York, E. A. Maher ; North Carolina, D. A. Tompkins ; North Dakota, Vincent S. Stone ; Ohio, Chas. R. Faben, Jr. ; Oregon, P. F. Morey ; Pennsylvania, A. J. De Camp ; Rhode Island, Marsden J. Perry ; South Carolina, George B. Edwards ; South Dakota, no member ; Tennessee, no member ; Texas, no member ; Vermont, M. J. Francisco ; Virginia, no member ; West Virginia, John B. Gardner ; Wisconsin, S. S. Badger ; Washington, no member.

A persistent effort is being made to complete the membership, so that every state shall be represented. It is hoped that a leading central station man in each of the states not represented will soon be found who will qualify as a member of the association, if not already a member, and accept an appointment as the representative of his state on this committee. The assistance of every member of the association, and of all others interested in its welfare is solicited, to secure this consummation.

Electric Executions.—The resolution adopted at the tenth semi-annual convention, directing this committee to use its efforts to secure the repeal of the electric execution law in the state of New York, has not been acted upon. The committee thought it best to make no move in that direction while the question of the constitutionality of the law was undetermined. While re-affirming our belief that the law should be repealed, we are of the opinion that if it is to be enforced, it should be done in the most effective and humane manner. That the law may be so enforced, we believe it necessary that it be so amended as to require a special apparatus to be devised for the purpose, that shall generate a current of not less than 10,000 volts. In this behalf, this committee recommends the association to instruct it to co-operate with the New York State association in securing such amendment of the law.

State Associations.—Since the tenth semi-annual convention this committee has engaged in the work of promoting the organization of state associations. The reason for this action is based on the fact that all legislation affecting the interests of central station companies, is either state or municipal. A state association is necessary in order to provide a medium through which the central station companies doing business in a state can act to accomplish a purpose in which they have a common interest. As there is no uniformity in legislation as between states, state associations are necessary to enable the national association to carry out the "plan of work" adopted for this committee in the most effective manner. Through the grouping of central station companies into state associations, and of state associations into the national association, the full strength of the prestige and influence of the entire industry of the country can be brought to the support of any state association or of any central station company needing assistance.

In pursuance of this policy, state associations have been organized in the following states :—

Massachusetts, Maryland, including the district of Columbia Connecticut, Rhode Island, New Hampshire, Maine, Michigan, Illinois, New York, New Jersey.

This work will be continued until all the states are organized. Membership in these associations is confined to central station companies doing business within the state. Any such company may become a member and be represented in the meetings of the state association by any one or all of its officers or employés, one of their number being designated to cast the vote of the company at the meeting.

While subjects of legislation have been the exciting cause for these organizations, it is expected that in the course of time the development of the work that may be accomplished through them, will render the legislative feature of the least importance or benefit. The improvements in electrical business methods that can be initiated or perfected through the bringing together of those having a common interest in such subjects cannot well be overestimated.

In view of the number of state associations now organized, and the prospect of the organization of a number of additional states in the near future, this committee recommends the association to instruct it to report for the action of its next convention, such changes in the constitution as will, in its opinion, best provide for the membership and representation of state associations in the national association.

Dangers to Investments in Central Station Companies.—Closely allied with the subject of legislation is the subject of the business methods by which manufacturing companies seek to make sales of their apparatus. As this committee was created for the purpose of instituting measures for the protection of the capital invested in electrical central stations, it considers the subject of the competition of manufacturing companies with central station companies for public lighting contracts, to be a most proper subject for the consideration of the association.

Within the last six months every dollar invested in electric central stations has felt the depreciating influence of an excited and misinformed public opinion. From such a cause these investments must continue to suffer until the means is found of furnishing the public with information that it can accept as being reliable, impartial and authoritative. While the damage done in this direction is great, it is not vital. The evil can be corrected.

Of a different character is the damage done to central station investments by those manufacturers who have, either openly or under cover of other names, sought to create a market for their apparatus by underbidding an established local company in its proposal for a public light contract. A low bid for public lighting is invariably used as a means of obtaining a franchise and the right to do business in a city or town in opposition to an existing company. Manufacturers have acquired their power to do this through the wealth and prestige they have gained by supplying existing companies with their apparatus. No demand can be more just this: "The value of investments in electrical apparatus and construction that have been made on the basis of manufacturers' representations of earning capacity must not be depreciated by the cutting of prices, by or through the assistance of manufacturers."

This evil is vital. In destroying the profits of the business, the reason for its existence is destroyed. It is folly to discuss the mechanical or electrical efficiency of a plant, if its financial efficiency is to be destroyed by cutting the price to be received from the service it is to render, to a point which destroys all possibility of securing a fair profit for the use and risk of the capital invested in it.

For the correction of this evil the association must rely upon the work to be done by the co-operation of all central station companies to secure reasonable legislation and just conciliation.

DISCUSSION.

It was voted to take up the report by sections. On the matter of electrical executions the discussion was as follows:—

Captain Brophy—As this resolution reads, it means nothing. "A current of 10,000 volts," is meaningless and the statement could be used greatly to our disadvantage by interested parties.

Mr. Garratt—I was about to speak on that point. Electricity may kill people in two ways, by nervous shock or by cooking. If this is to be adopted, I would suggest two things: First, that in speaking of a current of 10,000 volts, these words be added, "If the machine be devised to deliver an alternating current, the pressure of that current shall be considered equal to the heating effect in a thin wire or carbon filament under a pressure of equal potential." That prevents this being thrown out on technicality. I would also add that this machine deliver through 2,000 ohms of resistance, not over two amperes nor less than one. That will kill a man in accordance with our ideas of humanity. A 10,000-volt machine might be devised which would be equal to the tortures of the inquisition multiplied by a great many powers.

Mr. Lockwood—I move that the recommendation read that special constant potential apparatus be devised to furnish a current of not less than 10,000 volts potential and capable of delivering not less than 20 amperes.

Mr. Faben—The committee did not feel that it was part of its province to specify a bill for passage by the New York legislature. The suggestion was simply made that the voltage be placed high enough to represent a blow and not a burn.

Mr. Perry—It seems to me that it would be better to let the state take care of that matter. The fact is, that the law has been adopted by the state and stands, and for political and other considerations it will stand, and it is impossible to procure enough votes to repeal it, and if you did so, you would be obliged to pass it over again. We want, if they are going to use electricity, to make a machine strong enough to kill and not have odium attached to an ordinary machine. I do not think we ought to say anything about alternating or direct currents.

Mr. Garratt—I withdraw my whole recommendation.

Mr. Lockwood—I move to amend by adding the words, "and capable of delivering a quantity of current unquestionably sufficient to kill."

Captain Brophy—With one ampere of current and 10,000 volts it is a good deal like killing a mosquito with a ten-ton hammer, to attempt to execute a criminal. If you take any notice of this at all, it seems to me you are putting yourselves in the position of killing a fly with a club, by recommending the adoption of special devices for killing criminals.

Dr. Mason—I like what Captain Brophy has said, but I hope that if they will use electricity for this purpose they will do it by machines specially devised for the purpose of killing and not for light.

Mr. Perry—This committee had in mind the very thought which Dr. Mason has expressed. I am here as the exponent and champion of no system. The fact that the state of New York had adopted certain machines to do this work, would be a serious disadvantage to that particular make of machine. Make the law state that it shall be 10,000 volts, and then that cannot be trifled with, for no executioner acting under the law would dare to announce that he had fulfilled its mandate in any other way except as provided by the statute. That is what we had in mind. If we leave this open they will construct a machine of such voltage as they choose, and they can come out and strike the very blow from their special machine that they originally meant to strike by securing an ordinary standard commercial machine. With that change we are in a position to relieve any electric lighting company from the odium of furnishing an ordinary instrument of execution for criminals. I hope this section will stand as it has been presented with the simple amendment, if Mr. Lockwood desires to add it, of a quantity of current that will insure the desired result beyond a question.

Mr. De Camp—I think Mr. Perry expresses very clearly the sentiments of the whole committee and the idea that it had in making that report. We cannot alter the law. The committee which has had the matter in charge, find that there is a strong tendency to keep it on the statute book; electric execution must be the law of the state of New York. A bungle of an electric execution, or one or two of them, means the repeal of that law just as sure as we are here to-day.

Dr. Mason—Can't we work just as strongly without any action on the part of the association? Do the committee need our action?

President Weeks—I will say that that matter was presented in strong language to the authorities in the state of New York on former occasions, and my idea in raising this point was, that the action of this association, which is a semi-scientific body be not unscientific; it seems to me that this section can, by a very simple amendment, be made to meet all the requirements. The committee thought it should receive some support.

Mr. Perry—I think there is something here to guard, and that is the interests of electric lighting throughout this land. No one can deny that it is important, if possible, to draw a broad line between the killing machine and the commercial lighting machine. The committee arrived at the conclusion after a very careful examination, that we cannot stop the action of the law, but the next best thing is to so far relieve commercial apparatus from the odium of being used for that purpose.

President Weeks—I wish to say that a few months ago I visited Mayor Maher, of Albany, who was the chairman of the committee appointed at our last convention to present this matter to the governor of New York, with a view of finding out what had been accomplished and what might be done. He told me that he had seen Governor Hill and the latter had expressed himself very positively against doing anything in the line of the petition which we had submitted to him. I then suggested to Mr. Maher that in order to relieve the commercial apparatus and avoid any strife between commercial interests, a recommendation be made to the authorities that special apparatus be devised upon the specifications of some eminent scientist who had no connection whatever with any commercial interest. Mr. Maher said that he thought something could be accomplished in that line, and that he had no doubt that if that line was followed up properly the desired result could be reached. While I have heard nothing from him on this subject I understand from the chairman of this committee that this matter has been followed up and that they have hopes of accomplishing by this means the desired results. I only want to have the action of the convention go out as technically correct.

The motion of Dr. Mason to adopt the section as read was then put and unanimously carried.

The reading of the report was then continued, and upon its conclusion Mr. De Camp moved the adoption of the recommendation to appoint a committee on revision of the constitution and on the formulation of by-laws. The motion was adopted.

The whole report of the committee was then adopted.

REPORT OF THE EXECUTIVE COMMITTEE.

Mr. Gerald W. Hart then read the report of the executive committee as follows:—

The executive committee has confined its work largely to the present convention; other matters connected with the association having been delegated largely to special committees. The following committees have made reports at this convention, and the reports have been accepted and spread upon the minutes: Committee on underground conduits and conductors, E. T. Lynch, Jr., chairman; committee on harmonizing electric light and insurance interests, P. H. Alexander, chairman; committee to confer with Mayor Grant in regard to the International Exposition of 1892, Dr. Otto A. Moses, chairman; committee on electrical data, A. R. Foote, chairman; committee to memoralize Congress on the abolition of custom duty on copper, C. A. Brown, chairman; committee on standardization of potential on electric street railways, E. T. Lynch, Jr., chairman; the national committee on state and municipal legislation, A. R. Foote, chairman.

The work upon which these committees have been engaged is of great importance to the association, and the reports show that the subjects entrusted to them have been carefully considered, and a great amount of work has been accomplished. The secretary informs us that the number of communications from these committees which have gone out to the electrical public exceeds 12,000.

The following committees have not reported: Committee on patent legislation, Arthur Steuart, chairman; committee on electrical execution, E. W. Maher, chairman. Owing to the fact that the members of the executive committee are so widely separated, but one meeting has been held prior to the present session, since the Niagara Falls convention, although the members have been in constant communication.

At the above-named meeting held at New York on October 25th, the date of the present convention was decided upon, and a general programme was outlined; also an important resolution upon the compulsory use of underground system for high potential circuits was passed.

The finance committee, a sub-committee of the executive committee, has audited and approved the accounts of the treasurer. A committee on credentials has been appointed for the purpose of examining the credentials of the active members.

The finances of the association have never been in better condition than at present, or the future more promising. The experiment of the past year of having the head-quarters of the association at New York, has proved to be an entire success.

Since the last convention there has been a net gain of 61 members; the total membership being now over three hundred. At a recent meeting the following names were unanimously recommended for honorary membership in the association, agreeably to the constitutional provisions therefor: See article 3, section 4, Sir William Thomson, Professor Henry A. Rowland, Chas. F. Bush, Thos. A. Edison, Professor Elihu Thomson, and Frank J. Sprague.

The report was then voted upon by a standing vote and unanimously adopted.

The association, on motion, then adjourned until 3 o'clock p. m.

FRIDAY AFTERNOON'S PROCEEDINGS.

The announcement that an exhibition of the phonograph would be given and that a phonograph speech by Mr. Edison was on the programme, attracted a large audience to the Coates Opera House. The convention was called to order at three o'clock. President Weeks called upon Mr. Marsden J. Perry, the new president. He was received with cordial greetings.

ADDRESS OF MR. PERRY.

I am deeply sensible of the honor which you have conferred upon me, by electing me as your president. I know at our convention in Chicago, there seemed to be a critical moment, a year ago, when a strong man, and a true one, was needed for the position of president of this association. Then it came to me on the instant that we had with us at that time the very man; a man of scholarly tastes, exceptional business ability, sound scientific acquirements, and the necessary firmness for an executive officer. His name was Edwin R. Weeks, of Kansas City. Mr. Weeks accepted the honor, and I assure you that when he did so it took considerable courage. Out of some confusion has arisen the present occasion, our annual convention, by all means the most successful, the most instructive one that we have ever held. We have assembled here to discuss the topics of interest to us. We have now about concluded our labor, and shall return to our toil. I wish to thank you in behalf of the National Electric Light Association for the wealth of hospitalities which we have enjoyed here in your city and at your hands.

You, Mr. President, have nearly finished your official course, and are about to lay down the duties and responsibilities—responsibilities, sir, in the acceptance of this office of which I am not unmindful. But in separating yourself from the office, you leave this association under a debt of gratitude and obligation that it will take long to repay. You take with you into your unofficial life, a bond of sympathy, a warmth and depth of feeling that will not soon be broken, marred or forgotten.

Gentlemen of the convention, the grand results which have been achieved from so small a beginning, have not been accomplished by a single hand. It has only been by united effort, and I shall rely on you during the coming year for a strong united effort as well as on your indulgence with me, that we may repeat again, if possible, the glorious record of the past year.

President Weeks then introduced Mr. E. H. Johnson who made a felicitous and inimitable address. He described to the convention and the large audience of citizens of Kansas City, the principles and history of the phonograph. He was particularly happy in telling of his early association with Mr. Edison, and in describing the various steps leading to the development of the phonograph as exhibited on the stage behind him.

At the conclusion of Mr. Johnson's address, the phonograph was brought into action, and after reproducing several cornet solos by Levy, it presented the following message from Mr. Edison:—

"Kansas City, Mo.

"My Dear Mr. Weeks:—

"When I had the pleasure of meeting you at my laboratory in December last, you suggested that I should send to the Kansas City Convention, which commences next week, a phonograph discussion upon the subject of my five-wire system of distribution, which you were good enough to assure me would prove of interest to the delegates, and ever since that time I have been trying to find an opportunity to prepare the data.

"My failure to do so has been through no fault of yours, as your letters have constantly kept the matter before me, nor has it been through want of inclination on my part that I am obliged to substitute this explanation.

"Certain urgent matters of business which I was unable to anticipate have occupied my attention to such an extent that I have even had to neglect the important work of my experiments.

"While I could not have contributed to the success of the convention, which is already assured through its location in your enterprising city, I regret that I am unable to send something which would at least be more interesting than this apology.

"Yours very truly,

"Thos. A. Edison."

After Mr. Edison's message had been enthusiastically received by the audience, the phonograph was again started up, treating the house to a xylophone solo with piano accompaniment, to the great enjoyment of all present.

"PARALLEL" COMPETITION.

The business of the convention was then taken up, and the following was offered by Mr. De Camp:—

Whereas, more than $100,000,000 have been invested in central electric light companies in America, and, *Whereas*, the stocks and bonds of these companies have been and are being depreciated and jeopardized by a reckless and disastrous competition, encouraged and fostered to a large extent by rival parent companies; and,

Whereas, this course of conduct threatens the destruction alike of central station companies and of parent companies, the profitable continuance of whose business depends upon the healthy life of the central station companies, therefore,

Resolved, that the National Electric Light Association appoint a committee of seven whose duties shall be to devise and execute plans for the prevention of the evils referred to, and,

Resolved, that the president appoint this committee, and that any vacancies occurring be filled by the incoming president.

The resolutions were supported by Dr. Mason, of Boston; Mr. Armstrong, of Camden, N. J.; Mr. Lockwood, of Detroit, and Mr. Francisco, of Rutland, Vt., and were unanimously adopted.

The chair announced the appointment of the following committees:—

On underground conduits and conductors—J. E. Lockwood, of Detroit; C. H. Wilmerding, of Chicago; Schuyler S. Wheeler, of New York; T. C. Smith, of Philadelphia, and David E. Evans, of Baltimore,

On revising constitution and by-laws—Dr. A. F. Mason, of Boston; A. J. De Camp, of Philadelphia; E. A. Armstrong, of Camden, N. J.; M. J. Francisco, of Rutland, Vt., and E. R. Weeks, of Kansas City, Mo.

On relations between parent and sub-companies—Marsden J. Perry, of Providence, R. I., chairman; J. A. Morrison, of Baltimore, Md.; J. E. Lockwood, of Detroit; Gilbert, of Boston; E. A. Armstrong, of New Jersey, and E. R. Weeks, of Kansas City, Mo.

Mr. George Cutter presented the following resolutions which were unanimously adopted:—

Whereas, It seems desirable that underwriters' rules governing the installation of electrical apparatus for light and power should be the same throughout the country, and that they should be as plain and concise as would be consistent with their efficiency, and

Whereas, In order to secure the formulation and adoption of such rules it seems necessary that the authority be vested in a committee composed of representatives of all parties interested; therefore, be it

Resolved, That the chair select and appoint a committee of five members of the National Electric Light Association, who shall have power to choose three representative electrical men to act on a committee for the purpose of devising and adopting national insurance rules, and considering any other matters affecting the joint interests of insurance and electrical companies, and be it further

Resolved, That the committee of five be requested and authorized to negotiate with the various general insurance organizations throughout the country with a view to securing the appointment by them of representatives on a national electric insurance committee, and that the committee of five report the result of its deliberations and actions at the next meeeting of this association.

Dr. Mason—I wish to introduce a customary resolution, which most fitting on this occasion. I move that the National Electric Light Association express to the people of Kansas City generally, to the railroads, the surface roads, the local reception committee, the transportation committee and all others who have extended us special courtesies, our heartfelt thanks as an evidence of our appreciation of all their generous treatment. I might add very much more, but no words that I could use would more clearly express my deep sense of appreciation of their kindness.

The resolution of thanks was adopted unanimously by a rising vote.

Secretary Garratt announced the reception of a letter from the chairman of the trustees of Guthrie, Oklahoma, inviting the association to visit that city.

Dr. Mason suggested that the association intrust Secretary Garratt, if possible, to visit Guthrie and express to the citizens of that city the good will of the association, taking with him any members who wished to accompany him. The motion was carried.

Secretary Garratt—I have one other letter, in reference to which I came very near violating my duties as secretary, which requires me to bring all matters before the convention. I am quite impressed by the effect the National Electric Light Association has produced upon the western people, as appears by a letter addressed to the association by a lady who informs me that she is an eminently respectable, minister's wife, and she encloses a dollar and a half and wants us to forward to her a pair of electrical corsets. (Laughter and applause.)

Dr. Mason moved that the secretary be instructed to grant the lady's request, which motion was carried by a unanimous vote amid much laughter and applause.

Chairman Weeks then said: "As we have finished our business, I now declare this convention closed."

PLEASURES OF THE CONVENTION.

Kansas City's hospitality will be long remembered by all who attended the convention. Her people entertained the visitors with open hearts and hands in truly western fashion. A numerous and well-organized reception committee met the special train on its arrival Tuesday morning with carriages in waiting to convey the travelers to their hotels, where all hands were comfortably bestowed without delay. Those of the visitors who were strangers in the city had opportunity for a stroll of an hour or two before the assembling of the convention at noon.

The Commercial Club, of Kansas City, gave a reception to the association Tuesday evening, at their handsome and commodious rooms in the New York Life Insurance Co.'s building. Toothsome viands and excellent punch graced their table, and were not slighted by the guests.

Cordial good fellowship was established at once. The Commercial Club comprises in its membership the leading business men of Kansas City. The honor and pleasure of meeting them in their chosen resort was highly appreciated and enjoyed by the members of the Electric Light Association and their friends.

The president of the club, Mr. F. A. Faxon, pleasantly welcomed the guests in a brief address. Among other good things, he said:—"We are always glad to meet those who are carrying on the world's great work. When we begin to realize what has been done in electrical science since Franklin's time, we are almost bewildered. Among the treasures of science none are more precious than those which have been obtained by those who have learned to control the lightning. It is a pleasure, therefore, for us to have such a distinguished body of scientists meet in our city.

"We have a city here which in its hustle and growth is perhaps without a parallel in the country. You must remember we are young. By the side of the buildings which tower to the sky are still to be seen the cabins of the pioneers, and the pioneers are still with us. In building up the city we want the best, and if you have the best then we want to buy it."

President Weeks happily expressed the acknowledgments of the association for the courtesies of the club.

The remainder of the evening was spent in informal conversation, many pleasant introductions of visitors and hosts, many of which will doubtless lead to future renewals of acquaintanceship so agreeably begun.

President Weeks and Mrs. Weeks paid a graceful compliment to the members of the association by going out over night to Kearney, 30 miles from Kansas City, and boarding the special train there Tuesday morning, making the last hour of the journey with the delegates and their friends on board.

Thursday, February 13, Mrs. E. R. Weeks and Mrs. F. B. Tiffany gave lunch parties to the ladies attending the convention. Thursday evening Mr. and Mrs. Weeks gave an informal reception, at their house, to the gentlemen of the convention.

An extremely enjoyable excursion was made Wednesday, February 12. By invitation of the Chicago, Milwaukee & St. Paul Railway Co., and the Excelsior Springs Hotel Co., the delegates and their friends were conveyed to the Springs by a special train, and were there entertained at dinner by the hotel company. The visitors were unanimous in their admiration of the Excelsior Springs establishment and in appreciation of the lavish hospitality of the hotel company.

A delightful break in the journey to Kansas City was made at Chicago. On the invitation of the Chicago Electric Club the afternoon of Monday, February 10, was devoted to a "stop over," and the enjoyment of a reception and lunch at the club rooms. Members of the club were out in force at the Union depot on the arrival of the "electric limited." They took possession of the company from the train, who were driven directly to the club rooms. Special provision was made for the comfort and entertainment of the ladies of the party. After an hour or so of informal sociability, meetings of old friends and the acquisition of new ones on both sides, the entire company assembled in the large hall of Kinzey's, where an elegant lunch was served. Mr. F. G. Beach briefly but heartily welcomed the visitors from the east and north, and introduced Mayor Cregier, who addressed the assemblage in behalf of the city of Chicago, bidding all to make themselves at home, to remember that Chicago and New York were sister cities, alike in many respects, particularly in their common desires towards the forthcoming world's fair. In behalf of the guests, brief remarks in acknowledgment of the courteous attention of the day were made by several of the eastern delegates. After the reception the visitors separated, many of them spending an hour or two in seeing points of interest conveniently accessible in the city, under the guidance of members of the club, all of whom were unremitting in their attentions till they bade good-bye to their guests as the special train rolled away for Kansas City at five o'clock.

COLLEGE NOTES.

Harvard University.

The freshmen lectures on physics began Thursday, February 20. They will be eight in number, given by Professors Trowbridge and Hall. These lectures, although primarily intended for freshmen are open to all members of the University, and several of the upper classmen have expressed the intention of attending regularly.

At the Cambridge manual training school, by a special arrangement between the University and the directors of the school, a number of Harvard men receive instruction in shop work. The school was established by the generous donor of the new Public Library and new City Hall of Cambridge, Mr. Ringe, of California. On the ground floor are two large rooms, one for wood work, the other for metal work. Between them is the forge and boiler room. Both departments are fitted up with machines and tools of the latest types. Power is furnished by a Brown engine. During the Christmas recess the students wired the building for incandescent lamps, under supervision of an expert. A 200-light Thomson-Houston dynamo is to be installed.

Mr. H. S. Wilkinson, '91, has been elected secretary of the Electric Club in place of S. K. Perot, L.S.S., who resigned on account of pressure of other duties.

February 26, Mr. C. H. Davis, of New York, who is a nephew of Professor Davis of the scientific school, will give an informal talk before the Electric Club on "Practical Electrical Engineering." On the 12th G. T. Page, '92, spoke on "Steam Engines used in Electric Lighting." The talk included an explanation of the leading types of stationary engines, and was illustrated by a number of photographs and charts.

Professor B. O. Pierce, of the Physics department, is seriously ill with a slow fever, brought on by overwork. He will be unable to resume his work for some time. Professor Pierce is very popular with the students, and has the sincere wishes of all for his speedy recovery. At last accounts he was gaining, though very slowly.

In physics 4 (electrodynamics) a new method of laboratory work will be employed during the last half year. The students are divided in pairs, and to each pair is assigned an experiment—Weber's determination of the Ohm, for instance. The men are expected to work out the experiment themselves by consulting the best works on the subject, and devising arrangements of apparatus. The instructor and assistant are always ready to answer questions or give advice, but the student is expected to rely on himself as much as possible. At the conclusion of each experiment a written report is to be submitted. This method is similar to the one employed at the German laboratories.

The Electric Club has lately received a number of handsome photographs of the Ball engine, also large charts and engravings of the Hamilton-Corliss engine, and blue prints of the Harrisburg Ide engine; also a treatise on the Porter-Allen engine, and a number of fine catalogues of the Buckeye A. & S., Straight Line, Watts-Campbell, Reynold-Corliss and Russel engines, and a large chart of the Jarvis furnace. More are to follow, and the club expects to have as fine a collection of descriptions of leading engines as can be found anywhere.

Cornell University—Sibley College.

Several important additions have recently been made to the material equipment of the department of electrical engineering and physics. Four small Edison dynamos, each of 250 Watts capacity, have been purchased by Dr. Thurston. They will be used entirely for experimental purposes. A Westinghouse 650-light alternator has been exchanged for a Stanley alternator. This machine is furnished with two armatures, one of which regulates for constant current, the other for constant potential. Tobey and Wallbridge, '90, will make a study of this new machine in their thesis work. The Westinghouse Electric Co. are also constructing a small alternator which will be used for experimental purposes.

Two Sprague 10 motors will soon be added to the department. Twelve sensitive galvanometers are being constructed in the department of physics for use by the Juniors in their laboratory work. The coils of these instruments are interchangeable and vary in resistance from 0.1 to 10,000 ohms. An improved Poggendorf switch, designed by Professor Moler has been placed in the laboratory. This switch is run from the line shaft and by means of cone pulleys 9 speeds, giving alternations varying from 3000 to 36000 per minute, may be obtained. It is used for the calibration of alternate current ammeeters and voltmeters. By means of two sets of brushes sparking is reduced to a minimum, a current of 10 amperes being alternated with no serious effects from that cause. L. B. Marks, R. G., has designed an alternator which will be constructed by the department of physics. The machine is of the mordey type, and has a capacity of 200 volts and 10 amperes. It is also designed to be used as a synchronous motor, its exciter being so made that it can be used for starting the motor from an alternating circuit. Mr. Marks proposes to make a study of the machine for a thesis, making a comparison of the theoretical with the actual results obtained from the machine. It is proposed to construct a number of transformers, varying from 5 volts and 400 amperes up to 10,000 volts and a fraction of an ampere, which are designed to be used with the alternator.

A small electric lighting station is in successful operation in the mechanical laboratory. The work of the seniors in that department consists of complete efficiency tests of the entire plant from the coal pile to the arc light.

The Senior Electrical Engineering Association organized at the commencement of the college year, has held a series of interesting and successful meetings during the present term.

The following papers have been read :—

F. N. Waterman, '89, "Practical Experience with Arc Lighting;" J. W. Cowles, '90, "The Thomson-Houston Railway System;" Professor A. S. Hathaway, "Molecular Dynamics;" Professor E. L. Nichols, "Historical Sketch of the Theories of Magneitsm;" A. H. Herschel, '90, Electric Railway Signals ;" J. E. Greenwalt, '90, "Practical Experience with Incandescent Lighting ;" W. B. Tobey, '90, "Methods of Wire-Drawing and Annealing;" Professor F. Osborne, "Building Materials for Electric Lighting Stations ;" Professor H. J. Ryan, "History of the Atlantic Telegraph." Professor Nichols is delivering lectures this term on the "Mathematical Theory of the Dynamo." This course of lectures will be followed by another course on "Photometry in Relation to Electric Lighting." Professor H. J. Ryan is giving a course of lectures on "Design of Alternators and Transformers." Under his direction the work of Seniors for the present term in the draughting-room consists of the design of continuous current generators and motors, alternate current generators and motor, open and closed circuit transformers.

Mr. E. G. Merritt, instructor in physics is giving, an electric course of two hours per week in the "Mathematical Theory of Motors, Alternators and Transformers." S. C. Thompson's Dynamo-Electric Machinery is used as a text-book.

On Feb. 21, Professor Alexander Graham Bell, one of the Sibley non-resident lecturers, delivered an illustrated lecture on "Radiophony." The lecture consisted of an historical sketch of the invention of the radiophone and its subsequent improvements. The apparatus used in the lecture has been presented by Professor Bell to the college,

The annual inspecttion tours of the mechanical and electrical Engineering students have been so successful and profitable that an increased range has been given to the tour of 1890. The programme includes itineraries, east, west and south, the classes being divided into three sections. The routes have been very happily arranged by Dr. Thurston to include typical establishments and installations in the several regions to be visited. The tours will begin March 20.

THE LOW TENSION BILL DEFEATED IN VIRGINIA.

The first serious attempt to limit by legislative action the voltage of electric currents employed in the distribution of light and power as originally recommended by Harold P. Brown, and endorsed by Mr. Edison in his article in the *North American Review*, has been made and has failed. About the first of February, Senator Lovenstein introduced a bill into the Virginia legislature "for the prevention of danger from electric currents." The bill was referred to the committee on general laws, who gave a hearing to parties interested on the evening of February 11, at which both the advocates and the opponents of the bill mustered in force. The most important provision of the proposed act is contained in the following extract :—

> In all electric circuits or parts of circuits, whether they be in whole or in part under or above ground, the electric pressure used shall not exceed the following amounts : The non-pulsating continuous current to a pressure not exceeding 800 volts ; the pulsaling continuous current to a pressure not exceeding 550 volts : the alternating current to a pressure not exceeding 200 volts, according to the nature of the current used.

An announcement that Mr. Edison himself would attend the hearing and speak in advocacy of the measure attracted a large audience.

Senator Lovenstein said he had introduced the bill at the request of several of his constituents and that his sole object was to protect property and persons from danger. The bill was introduced in the interest of no one concern or monopoly, but for the public weal. He then introduced Mr. Boulware the attorney for the Edison company, who said that the great loss of life and destruction of property by electricity was what impelled the gentlemen whom he represented to ask for the passage of the measure. He was present in the interests of the public. Electricity was one of the greatest of powers, but exceedingly hard to manage, and less was known of it than any other agent of force. The public alarm had now become so great that unless increased safeguards were thrown around the management of the wires electricity would have to be abolished. Everybody was apprehensive, and there was a general clamor that the electric current should be made safe. His clients asked for no monopoly. It was merely proposed to fix a limit within which all companies may operate without danger, and without changing their system. Mr. Boulware then introduced Mr. Edison and Mr. Harold P. Brown, stating that one was the "father of electricity," and the other an "electrical engineer of distinction."

Mr. Wyndham R. Meredith then took the floor and outlined the opposition to the bill. After paying a graceful compliment to Mr. Edison, he went on to say that he could not see why gentlemen from New York, unacquainted with the surroundings, should trouble themselves to come to Richmond to look after a matter that was wholly local in its bearings. He believed this bill had been prepared in behalf of some special commercial interest rather than the safety of the people. No one in Virginia had been hurt by electricity so far as he knew, and in any event he thought the passage of this bill would tend to increase rather than lessen danger. He said he represented the Schuyler company and the Virginia Electric Light and Power Co., both of which, if this bill became a law, would have to go out of existence.

Mr. Edison's remarks, which followed next, were in the form of answers to previously prepared questions asked by Mr Boulware, and these were ingeniously devised to bring out only such points as would forward the proposed legislation. Mr. Edison said that all that was needed to enable all companies to use a safe system of arc lighting is a small expenditure of money. He said emphatically that the charge that the intent of the bill was to press out other companies than those operating under the Edison patents was utterly untrue. "Other companies will not be driven out of the field" he declared "but let them conform their system to ours." While speaking, Mr. Edison put his hand in his pocket, pulled out a piece of paper, and said that while he considered the bill a reasonable and proper measure he would like to suggest an amendment to it. He then read from the paper the following :—

> After the passage of this act it shall not be lawful for any individual or corporation, public or private, to generate or use or cause to be used for distribution to the public, directly or by induction, any electric current with sufficient electric pressure to produce human death accidentally by the direct action of such current.

The committee looked at each other in some surprise at Mr. Edison's somewhat unusual proposition to amend a bill pending before the legislature.

A number of the committee asked what changes would be necessary in existing plants and what would be the cost.

"Well," said Mr. Edison, "for a town of about 5,000 inhabitants, say Lynchburg for instance [great laughter], about $10,000 or say 10 or 12 per cent."

Mr. Edison said he had no patent, either on high or low pressure. Through the persuasion of his partner he had bought indeed a system a few years ago (referring to the Zipernowski-Deri system), and subsequently felt like putting a skull and crossbones or white cap's notice on the shield.

Mr. Harold P. Brown next addressed the committee and in half an hour's speech gave a full account of himself and his discoveries. He thought it would be better to have no specific limit to the voltage mentioned in the bill, the better way being to test everything by "trying it on a dog." He closed with a lengthy citation of alleged instances of deaths from electricity in various parts of the country.

Professor Henry Morton was next introduced, who, after a clear but brief explanation of the peculiarities of the several different forms of electric current mentioned in the bill, addressed himself to the statements made by his predecessor.

All that Mr. Brown has said about electric currents," said Professor Morton, "has been known for 25 years. There's nothing new about that. Nobody pretends that the alternating current is safe. At high pressure, with less volts, it will kill quicker than any other. But it is not a question of having a system that is absolutely safe. A railroad train that runs 40 miles an hour is less dangerous than one at 60 miles an hour, and one at 20 is safer still, and at six miles an hour it is far less dangerous, but on that account are you going to give up railroad traveling? Kerosene lamps are dangerous, but are you going to give them up because every few days one explodes and somebody gets killed? Street cars are dangerous, and so are hundreds of other every day conveniencies I might name, but are you going to give them up on that account? If you are, you might as well go back to barbarism. So you see it is not a question of getting something that is absolutely not dangerous, but only for surrounding dangerous things with proper precautions. Steam boilers have often killed people, but nobody says turn out the boilers. The idea instead was to construct them that they could carry a high pressure of steam, and those that carry the most pressure are the strongest. He thought that the bill before the committee, if passed, would require the adoption of Edison's patent, and oblige the other companies to pay each a royalty as to make their own business profitless.

Judge Theodore Garnett, of Norfolk, said that no accident from electricity had ever occurred in his city, but nevertheless, if the bill passed, $25.000 worth of electrical plant in Norfolk would have to go out of existence. [At this point the hearing was adjourned for the day, but was resumed next morning.] Judge Garnett, continuing, said that this bill had not been called for by public opinion in the state; that no petition recommending such a law had been presented to the general assembly by anyone, and that every practical man connected with electric interests was opposed to its passage. If the promoters as they claimed were actuated by purely philanthropic motives, why should they come here from New York and New Jersey, where persons had lost their lives owing to absolute carelessness, and endeavor to induce the legislature of Virginia to pass such a law as this, when only a single case could be brought forward where anyone had ever been injured by electricity in this state. Why not have such laws passed by the legislatures of New York and New Jersey now in session?

Mayor Ellyson, of Richmond, who spoke next, believed it unwise that such a bill should be passed by the assembly, and, moreover, asserted that the city authorities were entirely competent, and had full power to deal with the subject whenever the necessity arose.

Senator Barry made an eloquent speech in opposition to the bill which was frequently applauded, and closed by asking that the City of Liberty be exempted from the operation of the bill should it become a law.

Mr. Chamberlain, of Norfolk, spoke briefly opposing the bill.

The Piedmont Electric Illuminating Co. through its president, and the cities of Alexandria, Petersburgh and Danville through their senators also protested earnestly against its passage.

At 11.30 A. M. the committee retired to their room to formulate their report to the senate. After consideration they agreed by a vote of 11 to 0 to recommend that the bill be not passed, expressing the opinion that the subject was one which each municipal authority could most properly deal with for itself, and that no legislation on the part of the state was desirable or necessary.

MANUFACTURING AND TRADE NOTES.

THE BROWN & SHARPE MANUFACTURING CO., Providence, R. I., have been so long distinguished for the range of their production of machinery and tools of the highest class of excellence, that any mention of their merits would seem superfluous. Some of their illustrated circulars are almost as gratifying to look upon as one of their symmetrical and handsomely finished machines. The illustrated supplement to their catalogue delights both the mechanical and the artistic eyes. The engravings leave nothing to be desired in clearness and beauty, while they are sumptuously printed upon a creamy background, giving something of the effect of Japan paper.

Readers are doubtless aware that the Brown & Sharpe Manufacturing Co. received "The Grand Prize" for their exhibit at the Paris Universal Exposition of 1889.

THE POND ENGINEERING CO., of St. Louis, are prominent among similar establishments that have taken up the design, contracting and constructing of power plant for electric lighting and power stations. They make complete outfits for such purposes a specialty. Their latest circular embraces a variety of engines, boilers, pumps, and special appliances for the equipment of stations of varying requirements. The Pond company have fitted out a large number of stations in the west.

S. H. TERRY, 4012 North Grand avenue, St. Louis, Mo., has put upon the market a sheet steel pole for electric railway and electric light wires, that seems to possess merit in several particulars. It is light and rigid, and, says Mr. Terry, the most economical pole yet put upon the market. These poles are in use on Mr. John Scullin's Union Depot Electric Railway in St. Louis.

THE PHOSPHOR-BRONZE SMELTING CO., Limited, Philadelphia, original manufacturers of phosphor-bronze in the United States, have issued their Price List, No. 7, 1890. A glance at the index suffices to indicate the wide range of use already attained by their product. The metal is furnished in sheets, rods, ingots or castings. It is manufactured by the Phosphor-Bronze Smelting Co. into wire (for springs or for electrical purposes), ropes, wire-cloth, nails and tacks, rods and bolts, screws, chains, pens and tools. It is made of varying temper to suit special purposes, and has found its way into many branches of manufacture and trade where copper and brass were formerly employed.

THE GARVIN Universal Milling Machine, with its various attachments is meeting with deserved favor in many workshops. The Garvin Machine Co., Laight and Canal streets, New York, issue a special circular describing the milling machine and its accompanying devices, with prices for the several sizes manufactured. The circular contains a detailed example in bevel gear work that will be found instructive to beginners.

MR. JARVIS B. EDSON, of 87 Liberty street, manager of the Edson Pressure Recording Gauge Co., recently remodeled his offices, and has given them a very attractive appearance. He has on exhibition a large number of charts taken from his recording gauges, which demonstrate their usefulness and show that firemen take pains to keep their steam pressure steady when they know that it is being recorded. These gauges are in use in many prominent electric light stations. Two of the gauges were, not long since, installed in the new Edison station in Brooklyn, and one has recently been set up in the Denver Edison station. To these may be added the installation in the electric light plant of the Pennsylvania Railroad Co., at Jersey City, the Syracuse Heat and Power Co., the Excelsior Electric Power Co. and the East River Electric Light Co., of this city.

STREET RAILWAY NOTES.

THE THOMPSON-HOUSTON ELECTRIC CO. continue, notwithstanding the unfavorable season of the year, to start running electric railway lines that they have been constructing during the latter part of 1889. Among the roads put in operation by them since January 1 are the following:—Macon City and Suburban Ry. Co., Macon, Ga., 8 miles, 8 cars; Minneapolis Street Ry. Co., Fourth avenue, Minneapolis, Minn., 8 miles, 10 cars; Ross Park Street Ry. Co., Spokane Falls, W., 7½ miles, 10 cars; Grand Avenue Line, St. Paul, Minn., 6 miles, 2 cars; St. Louis & E. St. Louis Electric Ry. Co., St. Louis, Mo., 2 miles, 6 cars; National Electric Tramway & Lighting Co., Victoria, B. C., 4 miles, 6 cars; Doncaster and Box Hill Tramway Co., Victoria, Australia, 2 miles, 1 car.

The Thomson-Houston company have made the following recent railway contracts: Augusta, Hallowell & Gardiner Ry. Co., Augusta, Me., 3 miles, 3 cars; North Side Ry. Co., Fort Worth, Tex., 15 miles, 8 cars; Gloucester Street Ry. Co., Gloucester, Mass., 5 miles, 3 cars; Port Townsend Street Ry. Co., Port Townsend, W., 3 miles, 2 cars; Springfield City Ry. Co., Springfield, Ill., 7 miles, 8 cars; Boston Construction Co., Spokane Falls, W., 7 miles, 7 cars; Inter-Urban Line, St. Paul, Minn., 22 miles, 15 cars: Northwest Electric Construction & Supply Co., West Superior, Wis., 2 miles, 1 car; Douglas County Street Ry. Co., West Superior, Wis., 4 miles, 2 cars; Winona City Street Ry. Co., Winona, Minn., 4 miles, 5 cars.

ST. LOUIS, MO.—The Lindell street railway line, of St. Louis, Mo., where there are now 12 Sprague cars in operation, will be supplied with electric equipments throughout with the Sprague system. Double bracket iron poles placed between the two tracks will be used, and will be of an ornamental and tasteful design. Each pole will carry an arc lamp, and so will act for the double purpose of lighting the street and carrying the trolley wires.

The only wires overhead will be the trolley wires. The main feeder and arc light wires will all be carried underground.

MINNEAPOLIS AND ST. PAUL.—After a careful examination of all the systems of railway propulsion, both cable and electric, the management of the Minneapolis Street Railway Co., which controls all the street railway lines in the cities of Minneapolis and St. Paul, with an aggregate of 200 miles, has adopted electric traction, and on the 19th of February closed a contract with the Sprague Electric Railway and Motor Co. for the electrical equipment of its roads.

SOME CAR RECORDS.—When electric railways were first introduced, street railway men said that the motors were not sufficiently durable for the necessities of street car service. That may have been true then; but the durability of the electric street railway motor, as exemplified in the productions of the leading manufacturing companies of to-day, is probably as high if not higher than that of any other machine exposed to similar conditions of service.

At Erie, Pa., on the line of the Erie Electric Railway Co. one motor car has run 19,300 miles without requiring repairs of any kind. A second car, equipped with only a single motor, has run 15,000 miles without repairs, and other cars have records closely approximating the above.

The Erie electric railway has been in operation for several months on the Sprague system, and is said to be giving entire satisfaction to the managers of the road, and to the general public.

The equipment of the road is complete in every respect. At the station the power plant includes two 150 h. p. Ball engines, with 16″ x 16″ cylinders, each engine being belted directly to two 50,000 Watt railway dynamos which furnish the current to the line. There are 15 electric cars equipped with the Sprague improved motors and all the latest attachments and devices used by the Sprague company upon its cars.

CAR-HEATING COMPANIES CONSOLIDATE.

Early in February, George Westinghouse, Jr., and C. H. Jackson, president and vice-president respectively of the Standard Car-Heating and Ventilating Co., of Pittsburgh, Pa., became directors and large shareholders in the Consolidated Car-Heating Co., of Albany. The interests of the Pittsburgh company were thus consolidated with the Albany company, which, by this arrangement, greatly extends the field of its operation and becomes the owner of an additional number of valuable patents and improved devices for heating and ventilating railroad cars and for lighting such cars by electricity. Automatic regulation of heat, which will obviate the complaints of the variable temperature of steam heated cars, is also secured by an attachment to the air-brake cylinder with which all cars are already equipped. Several of the features of the heating systems of the Standard company have lately been on trial upon the Pennsylvania and the Baltimore and Ohio railroads, with favorable results.

INTERIOR ELECTRICAL CONDUITS.

On Friday, February 7, at the invitation of the Interior Electrical Conduit Co. a large company of gentlemen assembled at the works of the Bergman Electric and Gas Fixture Co. in this city, to witness some experiments designed to show the efficiency and convenience of the "interior conduit." The important departure in interior wiring introduced by the new company consists in providing a regular system of conduits or tubes within houses in the same way as pipes are employed for the distribution of gas. These tubes are made of a practically non-combustible compound, are light and moderately flexible, and through them the wires are drawn to each floor, chandelier or bracket as required. The tubes are furnished in sizes varying from ¼ to 1¼ inside diameter.

Mr. E. H. Johnson conducted the experiments with the assistance of Messrs. E. T. Greenfield and J. H. Vail, explaining the construction of the tubes, and the manner of their arrangement. The system was shown in use; conduits of various sizes being distributed about the room in which were wires feeding a considerable number of lamps.

Object lessons in running the tubes and inserting conductors were given clearly, exhibiting the simplicity of the system, and its easy application to all classes of interior wiring. Mr. Johnson described the dangers to interior wires as arising from three causes, viz: overloading, short circuits and leakage, the latter being the most dangerous and the one heretofore least guarded against. A leak might carbonize the material surrounding the wire and form a dangerous arc without blowing the safety fuses, and thus start a fire. To guard against this, the plan has been adopted by the Interior Conduit Co. of employing circuits in which the two conductors covered with good cotton insulation twisted together and covered with thorough waterproof insulation, and then braided—are carried in one tube. Thus a leak must immediately develop into a short circuit, the safety plug is blown at once, and the current shut out from the circuit. The formation of dangerous arcs through leakage is thus avoided This effect was experimentally shown the visitors.

Other equally successful experiments were made exhibiting the safeguard qualities of the tubing, as against overloading and consequent overheating of conductors.

Mr. Johnson read a report of test, made by Mr. A. E. Kennelly, at the Edison laboratory, of the insulating properties of the tubing. The report showed that a length of tubing, such as ordinarily made, gave, after three weeks' immersion in water, an insulation resistance of 15 megohms, or about 40,000 ohms to the mile. Thus, while the tubing is not relied upon for insulating the conductors it obviously affords practically absolute protection against dampness.

After the exhibition and experiments the party in attendance were handsomely entertained at the Hoffman House, where an elaborate luncheon was served.

THE EDISON GENERAL ELECTRIC COMPANY.

The following financial statement of the Edison General Electric Company, from official sources, will be of general interest. This company was organized in April, 1889, under the laws of the state of New York, for the purpose of acquiring the property, franchises and business of the several Edison manufacturing companies, and for the manufacture and sale of electrical apparatus, light and power.

The total capital stock of the company is		$12,000,000
Of which has been issued		7,612,700
Leaving in the treasury of the company		1,890,800
Of the total capital stock of the company there had been issued in exchange for stocks of various Edison companies, and to be so issued	$7,612,700	
Held in trust by Farmers' Loan & Trust Co	2,496,500	
Remaining in treasury Jan. 29, 1890	1,890,800	
	$12,000,000	

The Farmers' Loan & Trust Co. has issued its printed certificates against the above $2,496,500 of stock, deposited with them under deeds of trust, dated April 26 and December 26, 1889. Under the provisions of these trusts, the trust certificates will be exchanged for the stock deposited against them, whenever the trustees shall in any one fiscal year declare a dividend of 8 per cent. upon the entire capital stock of the Edison General Electric Co. then outstanding.

The companies which have been acquired by the Edison General Electric Co. are as follows:—

14,003	shares Edison Electric Light Co., out of 15,000 shares. Par, $100.
7,500	shares The Edison Machine Works. Entire capital stock. Par, $100.
7,500	shares Bergmann & Co. Entire capital stock. Par, $100.
400	shares Canadian Edison Manufacturing Co. Entire issued capital stock. Par, $100.
100	shares Edison Lamp Co. Entire capital stock. Par, $2,500.
13,920	shares Sprague Electric Railway and Motor Co., of which 8,720 shares were acquired since November 1, 1889. Entire issued capital stock except 80 shares. Par, $100.
1,000	shares Leonard & Izard Co. Entire capital stock. Par, $100.
5,000	shares United Edison Manufacturing Co. Entire outstanding capital stock. Par, $100.

The following statement shows the nature and extent of the business of these companies:—

Edison Electric Light Co.—This company owns all the Edison patents, and sundry other patents, for incandescent electric lighting in North and South America, and all patent litigation is conducted in its name. It grants exclusive lincenses for specified territory to local companies, receiving in payment therefor, as royalty, a proportion of all securities (stocks or bonds) issued, or to be issued, by such licensed companies. On October 31st, it held $1,749,573 of stocks and bonds of different companies acquired for such licenses. Its relation to such licensed companies is not only a stockholder, but also the grantor of a license, which it reserves the right to forfeit if its terms are not complied with. Its balance sheet is submitted as follows:—

Edison Electric Light Co., Balance Sheet, October 31, 1889.

Assets.

Property accounts—Permanent plants	$70,197 56	
Rental plants	25,345 80	
Supplies	5,307 11	
Cash accounts		$5,977 32
Patents		1,032,010 17
Customers		3,267 94
Customers, Elgin Edison Light Co		1,817 31
Bills receivable		60,768 10
Trust Fund, No. 1		51,612 39
Trust Fund, No. 2, D. M. & Co		25,343 08
Doubtful and extended accounts		8,009 69
T. A. Edison contingent account		1,019 30
Open accounts		33,542 09
Stock and bonds		1,749,573 00
		$3,073,790 86

Liabilities.

Capital stock		$1,500,000 00
General liquidation account		47,864 63
Sinking fund		1,029,671 21
Bills payable		22,747 10
Accounts payable		7,382 54
Open accounts		2,518 75
Profit and loss accounts—Profit and loss September 30, 1889	$466,114 34	
Profit and loss, current year to date	10,170 31	
	$476,284 65	
Less expenses current year to date	12,628 02	
	$463,656 63	
Less amount provisionally transferred by item next below	105,000 00	
		358,656 63
Special profit account		105,000 00
		$3,073,790 86

Edison Machine Works, Bergmann & Co., The Edison Lamp Co., Canadian Edison Manufacturing Co.—The four above-named companies (owned entirely by the Edison General Electric Co) are corporations engaged in the manufacture of appliances required to furnish light and power by electricity. Their plants and output are as follows:—

Edison Machine Works.—Plant worth $1,500,000, situated on 29 acres of ground at Schenectady, N. Y., employing 1,400 men, and having a present capacity of $3,000,000 a year output.

Edison Lamp Co.—Plant worth $1,200,000, at Harrison, N. J., employing 500 men, and making nothing but lamps, of which its present capacity is 8,000 a day. It has a branch factory at Hamilton, Ont., where lamps used in Canada are manufactured.

Bergmann & Co.—Two plants worth $900,000 in the City of New York, employing 500 men, and having a present capacity of $1,500,000 a year output.

Canadian Edison Manufacturing Co—Plant worth $40,000, at Sherbrooke, Canada, employing 100 men, started in pursuance to the Canadian laws requiring all patented articles sold in Canada to be manufactured there.

The consolidated balance sheet of the four manufacturing companies abovenamed is herewith submitted.

Consolidated Balance Sheet, Manufacturing Companies, Oct. 31, 1889.

Assets.

Consolidated Ledger Accounts.	Totals.
Property accounts	$1,382,496 72
Cash, accounts receivable and bills receivable	880,031 87
Material and stock on hand	897,200 80
Investments	9,765 00
Patents, rights, and royalties	286,750 80
Experimental account	84,094 12
	$3,540,339 31

Liabilities.

Consolidated Ledger Accounts.	Totals.
Capital stock	$1,790,000 00
Bills payable	97,502 86
Accounts payable	247,369 87
Edison General Electric Co. loans	1,024,227 64
Mortgages	65,000 00
Surplus, Nov. 1, 1889, after payment of dividends	316,239 44
	$3,540,339 31

Sprague Electric Railway and Motor Co.—This company is engaged in furnishing motive power for railways and in the transmission of power for manufacturing and general purposes.

Balance Sheet for December, 1889.

Assets.

Property accounts, being expenditures on work in progress, motors, material, etc	$399,264 85
General accounts, including customers' accounts, bills receivable, bonds, loans, cash, etc	742,629 64
Experimental property	8,051 44
Patents	672,500 00
Old experimental accounts	190,198 51
	$2,012,643 94

Liabilities.

Capital stock		$1,400,000 00
Liabilities—Accounts and bills payable	$598,045 00	
Loans	10,000 00	
Open accounts	2,152 12	
		610,197 12
Profit and loss—Profit: March 1 to Dec. 31, 1889.	16,166 81	
Loss: To Feb. 28, 1889	13,719 99	
		2,446 82
		$2,012,643 94

United Edison Manufacturing Co. and Leonard & Izard Co.—These corporations were organized to handle and sell the product of the manufacturing departments of the Edison General Electric Co., and they, instead of individuals, are the agents of the General company. They also act as construction companies, and contract for every kind of electric construction.

Edison General Electric Co., Balance Sheet, October 31, 1889.

Assets.

Capital stocks of sub-companies		$8,912,859 59
14,003 shares Edison Electric Light Co. 7,500 shares the Edison Machine Works, 7,500 shares Bergmann & Co., 100 shares Edison Lamp Co., 5,200 shares Sprague Electric Railway and Motor Co., 5,000 shares United Edison Manufacturing Co., 1,000 shares Leonard & Izard Co., 400 shares Canadian Edison Manufacturing Co.		
Cash on hand		$131,305 32
Subscriptions to capital stock		250,000 00
Open accounts—Loans to shops	$1,024,227 64	
Other loans	5,042 85	
		1,029,270 49
Real estate—Broad and New streets, New York city		136,756 18
Bills receivable—Received from sub-companies		543,981 83
Special profit and loss estimated—Edison Electric Light Co.		105,000 00
		$11,109,173 41

Liabilities.

Capital stock		$6,890,300 00
Capital stock in trust		2,135,900 00
Mortgage on real estate		85,000 00
Bills payable		710,000 00
Open accounts		608,571 93
Profit and loss accounts—Rentals from real estate.	$220 82	
Dividends from sub-companies	587,500 00	
	$587,720 82	
Special profit and loss estimated—Edison Electric Light Co.	105,000 00	
	$692,720 82	
Less expenditures	13,319 34	
		679,401 48
		$11,109,173 41

LEGAL NOTES.

ELECTRIC STREET RAILWAY INTERFERENCE WITH TELEPHONE SERVICE.

A Decision in Favor of the Railways

Rocky Mountain Bell Telephone Co. *vs.* Salt Lake Street Railway Co.

In December last, at Salt Lake City, Utah, there was tried the case of the Rocky Mountain Bell Telephone Co. against the Salt Lake City Street Railway Co., in which the plaintiff sought to enjoin the defendant from operating its lines on or along certain streets in that city, parallel with the telephone wires. The case was heard before Judge Lane, of the Third Judicial District Court of the Territory.

The evidence put in by the telephone company was to the effect that the service was so greatly impaired by the interference from the single trolley system used by the railway company as to be, in the case of many subscribers, practically useless, and the defense of the railway company was that the double trolley system was impracticable on their routes, and that the adoption by the plaintiff of the "McCluer system," or, at any rate, of a metallic circuit system, would be a complete remedy for the evils complained of.

The decision of the Judge, rendered January 16, denied the prayer of the complainant for an injunction. The Court concludes as follows:—

Assuming that the use of the metallic circuit would remedy the evil complained of, and that its use was equally practicable by either party to this action, the Court will not enjoin the use of the ground circuit by the defendant while the plaintiff continues to use it. It appears from the preponderance of evidence that the use of the metallic circuit by the plaintiff is practicable; while its adoption by the defendant would be an experiment; its practicability does not appear to be established. The prayer of the complainant for an injunction is denied."

A Decision Adverse to the Railways.

Superior Court of Cincinnati.

The City and Suburban Telegraph Association, vs. The Cincinnati Inclined Plane Railway Company.

Taft, *J.*:—This is an action to enjoin the defendant from using a system of electric railway propulsion known as the single trolley system, in running its cars upon the streets of this city and the roads of the county, because, as plaintiff claims, it does a great injury to the conduct of the public business in which it is engaged, *i. e.*, the maintenance for profit of telephone communication between a large number of subscribers in the city and county. Plaintiff alleges that it has been conducting its business under lawful grants of the legislature of the state and the municipal authorities, and by virtue thereof has lawfully erected many lines of telephone wires on the streets upon which the street railway of defendant is constructed and operated. That the defendant has no lawful authority to use electricity as a propulsive power for its cars; that the single trolley system in use by defendant conducts upon and induces upon the wires of the plaintiff erected on the same streets currents of electricity, which make it impossible to use those wires for the purpose of telephone communication; that the result is, that many of the subscribers of plaintiff have made complaint and threatened to discontinue the use of the telephone, and some have refused to continue payment for the same, all to the great injury of the plaintiff; that the damage is irreparable and continuous, and that plaintiff notified defendant before the erection of the single trolley system that it would result in a serious injury to plaintiff, and of the objection to the system.

The defendant answers, denying plaintiff's lawful right to operate telephone lines; avers its own lawful right to conduct a system of electrical railway propulsion; avers that the single trolley system is the only practicable one in use, and secures advantages to the defendant not afforded by any other; that plaintiff's difficulties arise from the defects of its own telephone system, in that, for economy, it uses the earth as a return conductor, and so invites onto its lines many disturbing currents, both natural and artificial, although the mechanism of the telephone is so delicate that any proper system would make the return circuit metallic; that plaintiff's claim amounts to a claim to the exclusive use of the earth as a conductor, which is without warrant of law; that the use by the defendant of the earth as a return circuit is a material assistance in propelling cars up heavy grades; that it could not alter its system so as to avoid the use of the earth as a return circuit except at great outlay and loss of efficiency. The answer denies that the operation of its road produces interference with the telephone lines of plaintiff, and says that, if any injury has been produced for which defendant is liable, the damages are capable of exact ascertainment, because they can all be remedied by an additional expenditure by the plaintiff, and that therefore there is no ground for equitable relief.

Plaintiff, by its reply, denies the allegations of the answer.

1st. The plaintiff company was organized in 1873 as a magnetic telegraph company, to conduct a telegraph business on lines within the city and between here and Hamilton, under laws which have since been incorporated in chapter 4, title ii, concerning magnetic telegraph companies. Section 3454 provides that "a magnetic telegraph company heretofore or hereafter created may construct telegraph lines from point to point, along and upon any public road, by the erection of the necessary fixtures, including posts, piers, and abutments necessary for the wires; but the same shall not incommode the public in the use of such road." Section 3461 provides that, "when any lands authorized to be appropriated to the use of a company are subject to the easement of a street, alley, public way, or other public use, within the limits of any city or village, the mode of use shall be such as shall be agreed upon between the municipal authorities of the city or village and the company; and if they can not agree, or the municipal authorities unreasonably delay to enter into any agreement, the probate court of the county, in a proceeding instituted for the purpose, shall direct in what mode such telegraph line shall be constructed along such street, alley, or public way, so as not to incommode the public in the use of the same; but nothing in this section shall be so construed as to authorize any municipal corporation to demand or receive any compensation for the use of a street, alley, or public way, beyond what may be necessary to restore the pavement to its former state of usefulness."

In 1878 the telephone, as a practicable commercial instrument, came into use, and the plaintiff became the licensee of the American Bell Telephone Co., with exclusive right to use all its patents in this city and county. Before this time, in 1873, the Common Council had passed resolutions fixing the terms under which the plaintiff might occupy the streets with its poles. From 1878 until the present time, the business of the plaintiff has grown to such an extent that it now has over 3,000 subscribers in the city and vicinity. The pole lines of the plaintiff along the streets occupied by the defendant's railway were erected in 1881 and 1882. In 1880, the following section was added to the telegraph law, 3471: "The provisions of this chapter shall apply also to any company organized to construct any line or lines of telephone; and every such company shall have the same powers, and be subject to the same restrictions, as are herein prescribed for magnetic telegraph companies."

The pole lines of the plaintiff are so erected under the ordinances of the city as to leave a bar at the top of each pole, on which to string the wires of the fire department telephone lines. The fire department and police department are each given a separate exchange, operated by city employes. The city strings its own wires upon the telephone poles, but pays nothing to the plaintiff for the use of the instruments, or for the general exchange work of the fire and police department. The poles have been erected at such places as directed by the engineer of the Board of Public Affairs, and under his supervision. The plaintiff has always used the earth as the return circuit. This has been the case with all the telephone systems in this country down to the present day, with the exception of certain long-distance lines from New York city, and the connecting subscribers who frequently use those lines in that city. The telegraph companies have used and still use the earth as the return for the circuit. The most complicated part of the telephone business is the mechanism by which temporary connection is made between any two subscribers' lines. It is called a switch-board, and each one of the exchanges, of which there are five in this city, is furnished with one. It is a very expensive instrument, and could not be adapted to use for a system of metallic circuits.

It will thus be seen that every step taken by the plaintiff was authorized by law, and that all that has been done by it has been with the consent of the proper authorities. From this statement, there can be no doubt that the plaintiff has a lawful right to occupy the streets upon which defendant's track is laid, with the poles and wires erected for the conduct of its business, and that the use of the earth as a return is not a violation of its franchise. It was organized and still is called a telegraph company. It began its telephone business before section 3471 was passed, and perhaps some of its poles and lines along the streets occupied by defendant were erected for such use. But this circumstance is immaterial, for it has been held, both in England and in this country, that the telephone system, which is communication over long and short distances through the agency of currents of electricity on metal wires, is really a magnetic telegraph system, and that an exclusive right to operate the telegraph includes the exclusive right to operate telephone lines.

Attorney-General *vs.* Edison Telephone Co., 6 Q. B. D. 244.

Wisconsin Tel. Co. *vs.* Oshkosh, 62 Wis. 32.

Nor does the passage of section 3471, which expressly makes the chapter on magnetic telegraph companies applicable to telephone companies, affect this conclusion. It was passed simply to remove the basis for an argument, and not because the chapter was not already sufficient to include telephone companies without it.

Chesapeake, etc. Tel. Co. *vs.* B. & O. Tel. Co., 66 Md. 399.

But, even if it were true that, when the plaintiff company, in 1878, began to use the telephone system, it was beyond its charter, it seems to me that the subsequent legislation of 1880 would have validated what before was *ultra vires*.

See Spring Grove Ave. Ry. Co. *vs.* Cumminsville, 14 Ohio St. 523.

I have not discussed, in this connection, the question how much the abutting property owners' rights were affected by the erection of the poles and wires of the plaintiff, because their rights are not in issue, and it is to be presumed, from the fact of plaintiff's occupation for so many years, in the absence of other evidence, that if any of the rights of the property owners were taken, they were ceded or sold to the plaintiff.

Having determined, then, that plaintiff's use of the streets, on which defendant operates its road, is lawful, the next question which arises is, whether defendant has the right to use electricity for the propulsion of its cars. If it has not, and it thereby interferes with plaintiff's franchise, it is very clear that such interference gives plaintiff a right of action. Defendant's counsel seems to contend that the question of *ultra vires* can not be raised against the defendant in this case; but that such an issue could only be made in an action by the state, or its delegated representatives, to oust the defendant from the exercise of such unwarranted privilege. This contention can not be sustained, for while it is true that if defendant is violating the limitations of its charter, plaintiff might request the attorney-general to institute *quo warranto* proceedings, nevertheless, it may rely on the fact of defendant's violation of its charter in a private litigation to show that the acts causing loss are unlawful.

City of Zanesville *vs.* Zanesville Gaslight Co., Supreme Court of Ohio, 23 W. L. B. 8.

The larger portion of the line now occupied by the defendant, was once operated by the Mt. Auburn Street Railroad Company, under a number of grants from the Common Council, the first of which was made September 2, 1864, and the last, November 14, 1873. All these grants were subject to the provisions of the general street railroad ordinance of 1859, that no motive power except horses and mules should be used on any road without the consent of Common Council. The franchise and property of the Mt. Auburn Railroad Co. was purchased by three persons: George A. Smith, J. M. Doherty, and Jos. S. Hill. On April 21, 1871, the Cincinnati Inclined Plane Railway Co. was incorporated under the general corporation act passed May 1, 1852, for the purpose of constructing a railroad whose termini should be in Cincinnati and the village of Avondale, and then constructed the inclined plane, still in use, connecting Locust street, Mt. Auburn, with the head of Main street. By ordinance, December, 1871, Common Council gave the company the power to lay tracks on certain streets which connected it with the Mt. Auburn street railroad tracks, with the express proviso that no motive power except horses and mules should be used on said tracks. A similar proviso was contained in an ordinance passed October 27, 1875, granting it the right to extend the tracks of the Mt. Auburn street railroad tracks to the north corporation line, at the Zoological Garden In 1876, an act was passed (73 Ohio L. 229), providing for the organization of inclined plane companies, and authorizing them to construct, operate, and maintain an inclined plane railroad for the conveyance of passengers and freight, or either, with such offices, depots, and other buildings as they may deem necessary; also, to establish and maintain a park or pleasure grounds, and for such purposes to hold real estate. Section 10 of this act, provided that whenever the part of the roadway of such railroad operated by steam power shall cross a public highway, such part of the railroad's railway shall pass either over or under such street or highway, and shall be constructed in such a manner and at such a distance above or below such street or highway, as not to obstruct the ordinary uses of such street or highway.

March 30, 1877, the legislature passed a law providing that any inclined plane railway company organized under the General Corporation Act of May, 1852, should have "the power to hold, lease, or purchase and maintain and operate such portion of any street railroad leading to or connected with the inclined plane as may be necessary for the convenient despatch of its business, upon the same terms and conditions on which it holds, maintains, and operates its inclined plane: provided, that no other motive power than animals shall be used on the public highways occupied by such street railway company without the consent of the Board of Public Works in any city having such a board, and the Common Council, or the public authority or company having charge, or owning any other highway in which such street railroad may be laid: and, provided, that no inclined plane railway or railroad company shall construct any track or tracks in any street or highway without first obtaining the written consent of a majority" of the abutting property holders.

June 19, 1877, George A. Smith, Jas. M. Doherty, and Jos. S. Hill leased the Mt. Auburn railroad perpetually to the Cincinnati Inclined Plane Railway Co. On September 24, 1885, the Board of Public Works passed a resolution consenting to the use by the defendant either of electricity, cable, or compressed air as a motive power "upon the highways in which the street railroads connected with its inclined plane, and held and operated by it are laid," on condition that defendant gave bond in $25,000 to hold the city harmless from any damages to persons or property arising out of the use of such motive power. On October 24, 1888, the Board of Public Affairs gave the defendant permission to erect along the entire length of its road the poles, wires, and appliances necessary to operate and maintain its entire line from Fifth and Walnut streets to the Zoological Garden as an electric road, in accordance with plans and specifications submitted to the board. The poles and wires were erected under the supervision of the engineer of the board. On February 23d, the stockholders of defendant extended its terminus to Glendale, Hamilton Co., Ohio, and certified the same to the Secretary of State under section 3306 of the General Railroad Chapter. And under such extension are now constructing a line of road along the Carthage pike under the consent of the County Commissioners, given March 23, '89, to use and occupy said pike with double tracks and with necessary appendages and appurtenances of an overhead electric street railroad system. This consent contains the provision that the County Commissioners are to cause the removal of any or all telegraph or telephone poles which may interfere with the operation of said electric road. The grant thus given was modified in September, 1889, but only with respect to the part of the street to be occupied.

Plaintiff's counsel maintain that on this record of the title of defendant, the present operation of this road is unlawful for several reasons.

First. That the act of 1876 providing for the incorporation of inclined plane railways requires that in passing over streets it should be conducted on bridges or in tunnels, and the act of May, 1877, provides that the operation of the railways to be leased shall be subject to the conditions upon which its inclined plane is operated.

Second. That the road connected with the inclined plane to be leased and operated by it under the act of 1877, was to be a "portion" of some other road, and that here the defendant is operating the entire road, nor is it shown that the road as used is necessary to the convenient despatch of the business of the inclined plane.

Third. That a proper construction of the first proviso of the act of 1877 requires that the consent necessary to permit the use of animal power shall be given by the Board of Public Works and the Common Council of the city.

As to the first reason, it should be said that it is doubtful whether the section referred to in the act of 1876 applies to defendant, for it does not appear that defendant ever accepted the provisions of that act as therein provided. Conceding, however, that the provision is of such a general character as to apply to any company running an inclined plane under whatever law organized, the restriction obviously applies only to places where the inclined plane itself crosses the streets, and not at all to what may be called surface street railroads which the Inclined Plane company is given power to lease and operate as street railroads are usually operated. The conditions upon which the inclined plane is operated, and to which the operation of street railways by the Inclined Plane company is to be subject, must, of course, be such conditions as are applicable to street railroads, of which the condition insisted on is obviously not one. Nor has the second reason, in my opinion, any weight. The original Mt. Auburn railroad company ran up Liberty, Price, Josephine, and Saunders streets. This portion of the road is not used now, but, being taken away, it leaves the part of Liberty to Fifth a portion, and that from Mason to the north corporation line a portion. As to the objection that such roads are not necessary to the despatch of the business of the inclined plane, I think it may be presumed that they are. It is common knowledge that the great difficulty to be overcome in reaching the plateaus about the city was in climbing the hills, and that the instrumentality by which that was accomplished became the principal feature of any such plan. The approach to the bottom and the departure from the top were incidental, and were certainly necessary to get passengers to the place of ascent or descent.

In so far as the third reason depends on the restriction in the grants to the Mt. Auburn railway to the use of horse and mule power, it is quite clear that subsequent legislative action enlarging the right of the lessee in this respect has been had, and no reason is apparent why it is not valid.

The chief argument is based on a construction of the proviso, "provided that no other motive power than animals shall be used on the public highways occupied by such street railway company without the consent of the Board of Public Works in any city having such a board, and the Common Council, or the public authority or company having charge, or owning any other highway in which such street railroad may be laid." Counsel for plaintiff argues that the body usually invested with the power of granting franchises for a municipal corporation, is the Common Council, and that it is not to be presumed that, in this case, the legislature intended to confer final power of that kind on the Board of Public Works, which is a body for the initiation of measures, not for their final legal sanction. Therefore, it is said, the word "and" before "Common Council" unites these two words with Board of Public Works, and the disjunctive "or" is the dividing word of the clauses, so that by a proper transposition it might be made to read "without the consent of the Common Council and of the Board of Public Works in any city having such a board, or of the public authority or company having charge, or owning, etc." This construction might be supported but for the use of the word "other" in the second clause. The clause is rather obscurely drawn, but the expression "any *other* highway in which such street railroad may be laid" means any highway additional to those already mentioned in which the same street railroad has been laid. The law is defining the consents required for one railroad passing through several jurisdictions. Therefore, we have the conjunctive *and* before Common Council to indicate that where a railroad has its beginning in the highways of a city having a Board of Public Works, and extends onto another highway beyond the city jurisdiction, it must have the consent of the Common Council or the public authority or company having charge, or owning such other highway in which such street railroad may be laid. The bill was evidently passed by the legislature with this city in their minds, for this is the only city in the state where an inclined plane would be necessary, and for this reason the peculiar phraseology is used. It would apply by virtue of the last clause after "*and*" to any other city, but as bearing on the effect of *and*, the probable and possible application of the law may be considered.

While it is true that to the Common Council is usually given the right to grant franchises, it is certainly within the legislative power to give it to the Board of Public Works or Affairs, and of late years there have been many instances where other powers, like those of passing ordinances to assess, and to make certain improvements, have been transferred from Council to the Board of Public Works. Moreover, if, by this law, the legislature intended to make the consent of the Board of Public Works and Council necessary, it was wholly superfluous to have mentioned the board at all, because, under section 2237 Rev. Stat., the Common Council could not grant such consent except upon the approval of the board. Some point is made of the presence of a comma after the words "Common Council" in the certified copy of the bill obtained from the Secretary of State's office, which does not appear in the printed law. I can not see that this materially affects the construction given above, for the certified copy shows the comma between board and the following *and* just as the printed law does, and that is the point where the question of a separation is important in construing the proviso.

On the whole, then, I am of opinion that the legislature conferred the right upon defendant to use any other motive power than animals, whenever the Board of Public Works should consent. Now, the board did consent, on October 24, 1885, that defendant should use either a cable, compressed air, or electricity. It has chosen electricity and has procured the necessary authority to erect its poles and string its wires.

Such being the condition of the franchises which the plaintiff and defendant are lawfully entitled to enjoy, considered each without reference to the other, it becomes necessary to inquire first whether any loss has been inflicted upon plaintiff by defendant, and if so, how it has occurred; second, whether such loss, if any, is justified by defendant's franchise, so as to be *damnum absque injuria*, which involves the preliminary question whether the legislature, after having given the plaintiff the right to construct its telephone system, on the faith of which right it has expended large amounts, can confer a franchise on another, the exercise of which will seriously impair the plaintiff's franchise as heretofore enjoyed.

First, a current of electricity can not be produced without a circuit, that is, unless the negative and positive poles of the generating battery or instrument are connected by a continuous substance, capable of conducting the current. Such a substance may be a metal wire, or if both poles of the battery be connected with the earth by metal wires, the current will find a circuit through the wires and the earth. The earth, by reason of its immense mass, makes an excellent conductor. By what paths the current discharged into it over the wire from one pole finds its way throughout to the wire from the other pole, is not capable of determination.

The telephone is a mechanism by which the sound of human speech is reproduced over long distances. Without attempting to describe the exact mode in which this result is brought about, I may say that the sound waves of the human voice produce vibrations in a thin ferrotype plate, which, by means of a magnet and an induction coil, are converted into corresponding variations in an electric current on the connecting wire, and these variations are, in turn, by means of the inducing coil and magnet at the other end, converted into exactly corresponding vibrations on a plate there, reproducing the sound waves of the voice of the speaker in such a manner as to enable the receiver to understand. The current on the connecting wire is a slight one, and the circuit is completed, not by a return wire, but by a ground wire brought into contact with the earth. This contact is usually made by attaching the wire from the negative pole of the single cell battery in each telephone, to a gas pipe or water pipe running down into the earth.

In the Sprague system of electric railways, which is the kind used by the defendant, the electricity used to operate the motors under the cars is conveyed to them by a single overhead wire suspended over the middle of the track, along the underside of which runs a trolley wheel on a single mast attached to the car, making electric connection between the overhead wire and the motor of the car, and allowing the current to pass down through the motor, and onto the track, whence some of it returns directly to the dynamo generator at the power house. A large part of the electricity leaves the track, however, and, by other and various paths, also finds its way through the earth back to the dynamo. In addition to the overhead trolley wire, which is supported by guide wires from iron posts erected on the curb at regular intervals, there is what is called a feed wire strung along on these posts for the purpose of keeping up the required quantity of electricity on the trolley wires. On the streets where are telephone wires, and electric railway wires, their general course must be parallel. The evidence in the case establishes beyond a doubt, that, since the defendant began the operation of its line by electricity, in June, 1889, down to the time of trial, the usefulness of all the telephones along the line of the railway have been more or less impaired; that, in many cases, the buzzing noise, which seems to be the chief form of the disturbance, has been so loud and continuous that communication over the lines has been impossible. Nor has the disturbance been confined to telephones on the line of the railway. Telephones several miles from the city, whose connecting wires ran parallel for any distance with the railway, were similarly affected, and the buzzing noise, in many of these, seems to have been quite as deafening as in telephones along the line. Altogether, more than two hundred lines have been affected in this way, to a greater or less degree. The cause of the trouble is undoubtedly the operation of the electric railways, and the way by which it is brought about is two-fold. First, the escape of the electric fluid from the rails, which is called earth distribution or leakage, near where the wire from the telephone is connected with the earth, brings upon this earth connection wire of the telephone varying currents of electricity of much greater quantity than that necessary for the telephone current, and produces upon the magnet and inducing coil an affect which results in vibrations of a very different character from those produced by the human voice, and makes a noise like the buzzing of a saw. Second, a similar noise is made by induction. It is a physical fact of much importance in electric mechanism that, where two wires of two circuits are parallel to each other, and there is a current of varying intensity on one of them, this will produce in the other, in the opposite direction, a current of electricity of similar variation. The insulation of the wires has no effect to reduce the current produced in this way. The amount of induction depends upon variation in the current, the distance of the wires from each other, and the length of the parallelism of the wires. The current upon the trolley wire, and the feed wire of the railway is quite variable in quantity and intensity, owing to the drain upon the store of electricity by the moving and stopping of the car. Nor is the electricity, as generated, exactly uniform in its flow from the dynamo. The result is that, wherever the telephone wire is parallel with the trolley wire and the feed wire, there is induced upon the telephone wire a current whose variations correspond with the variations of the electrical current on the electric railway wires, and this, acting upon the inducing coil and magnet, produces vibrations of the tin plate, which makes the buzzing sound. It is not possible, in listening to the sounds produced by the electric railway, to say whether it is the result of induction or earth leakage. Some of plaintiff's subscribers, notably Proctor & Gamble, have loud buzzing sounds upon their telephones, the ground wires of which are at such a distance from the railway track as to make it quite unlikely that the disturbance could have been caused by earth leakage, while, on the other hand, their wires are for some distance parallel with the trolley and feed wire of the railway company. Other telephones are disturbed on the line of the road, though their wires are not parallel with the trolley wire. Expert evidence attributed the disturbance about one-half to induction, and one-half to conduction or earth leakage. This, of course, is only a rough estimate, and the fact may vary much in particular instances. The injury to plaintiff's service is produced then, speaking in a general way, one-half by the defendant pouring electricity into the earth, which finds its way into the property of plaintiff's subscribers, and thence into the wire of the telephone, and one-half by a creation of a current on plaintiff's wires in the street by the parallelism of defendant's wire and the varying character of the current. The result has been a very substantial interference with the plaintiff's business, and, if the present condition continues, it will end in a serious loss.

Is it a loss for which defendant is liable? The contention on behalf of the defendant is, that because it has full power to operate by electricity under the law, the loss resulting to the plaintiff is *damnum absque injuria,* and if the plaintiff wishes to avoid the loss, it must adopt safeguards in the shape of a metallic circuit to avoid the difficulty. To this plaintiff replies, that, by virtue of its grants, it acquired, before the defendant had a right to use electricity as a motive power, a vested interest in the telephone system as it now operates it, with a grounded circuit, and that not even the legislature of the state could take away from it or injure this franchise, on the faith of which it has expended so much capital and labor.

I am inclined to think that, under the constitutional provision that all laws for the forming of corporations may be altered or repealed (sec. 2, art. xiii), it would be in the power of the legislature to grant a right to other corporations for a public use to so use the street as to require the plaintiff company, if it wished to continue in the telephone business, to change its system, and that without any right of action against such corporations. The case of Ry. Co. *vs.* Ry. Co., 30 Ohio St. 604, shows that, where one railway company condemned a right of way across the track of another, that other cannot recover for an injury to its franchise as a railroad or for the increased expense entailed upon it in obeying laws of the state with reference to railroad crossings. However this may be, I am very clear that no intention on the part of the legislature to abridge the granted rights of one corporation by a new grant to another will be recognized by the courts unless such intention plainly appears in the law. In England, the power of Parliament is unlimited, and it may even confiscate private property, and *a fortori* may abridge and destroy chartered rights and franchises. Nevertheless, we find in that country, that where one corporation is granted a right which may be so exercised as to injure or interfere with a right previously granted to another, the presumption of law is that Parliament intended only such uses as was consistent with the rights of the first corporation. In Gas Light and Coke Co. *vs.* Vestry, 15 Q. B. D. 1, plaintiff was a gas company, which had laid its gas pipes by virtue of a public grant under a street which the defendant, a public corporation, was charged with keeping in repair, and upon which it used such heavy rollers as to injure the pipes of the plaintiff. The rolls used were economical and well fitted for the purpose, but it was held that, unless the defendants were expressly authorized by statute to use rollers of the size and weight of those which did the injury, the defendant could not justify under a duty to keep in repair which might be discharged by rollers of less weight and without breaking the pipes. Says Findley, L. J.: "The authorities * * * show that an action lies for injury to property, unless such injury is expressly authorized by statute, or is, physically speaking, the necessary consequence of what is authorized. If in this case the defendants were expressly authorized by statute to use steam rollers of such a weight as necessarily to injure the plaintiffs' pipes, the plaintiffs would have no ground of complaint. The case would then be one of *damnum absque injuria.* The same consequence would follow if the defendants were expressly authorized by statute to repair in some way which necessarily required the use of heavy steam rollers or other machinery, which could not be worked without injuring the plaintiffs' pipes. There again, although such rollers or machinery were not expressly mentioned, their use would be authorized by necessary implication, and the plaintiffs would be without redress. But unless some statutory enactment can be shown to authorize the defendants to injure the plaintiffs' pipes the plaintiffs are entitled to redress." This case is peculiarly applicable to the case at bar, because here was a case of a public grant to the gas company enjoyed in a certain way, followed by a grant to the defendant to exercise another right, which if exercised in one way would injure plaintiff's enjoyment of its right, and which if exercised in another would not. The same principle is here applied that courts recognize wherever private property is injured by the exercise of authority granted by the Parliament.

See

Hammersmith, etc., Ry. Co. *vs.* Brand, L. R. 4 H. L. 171.
Queen *vs.* Bradford Navigation Co., 6 B. & S. 631.
Geddis *vs.* Proprietors of Bann Reservoir, 3 App. Cases 430.
Att'y Gen'l *vs.* Colney Hatch Lunatic Asylum, L. R. 4 Ch. App. 416.
Att'y Gen'l *vs.* Gas Light & Coke Co., 7 Ch. D. 217.
Managers Metrop. Asylum District *vs.* Hill, 6 App. Cases 193.

Even then, if franchises to occupy the public streets conferred by the legislature may be subject to modifications of their use and enjoyment by other public grants of the legislature, it is certain that unless the legislative intent to make such modification clearly appears, either by express words or by necessary implication arising from the impossibility of enjoying the second grant without such modification, it will not be inferred.

But it is said that this principal can have no place here because the right to occupy the street for the purpose of travel is a superior right to that of using it for the telephone poles. Defendant's counsel, to establish this, rely on

The Spring Grove Ave. *vs.* Cumminsville, 14 Ohio St.,
Smith *vs.* Tel. Co., 2 C. C. R. 259.
Mt. Adams & E. P. R. Co. *vs.* Winslow, 3 C. C. R. 425.
R. R. Co. *vs.* Williams, 35 Ohio St. 171.
Pike's Ex'rs *vs.* Western U. Tel. Co., decided by this court.

These cases have no bearing upon this case at all, as it seems to me. They involved a discussion of whether the erection of certain structures in the street could be considered a new burden and use, not included in the easement, which the abutting property holder had originally granted to the public, and whether, therefore, he was entitled to compensation. It is unquestionably within the power of the legislature, so far as the public is concerned, to enlarge the benefit to be derived from the streets, so as to include other public purposes than those of mere travel. Ry. Co. *vs* Lawrence, 38 Ohio St. 45. If this takes more from the abutting property holder than he originally gave, then he may have compensation, but the public can not complain, for their representative, the legislature, has spoken and granted the use. When the telephone company is granted the right to use the streets, its right is as well founded as that of a street railway company, and in the absence of express legislative direction to the contrary, there is to be no yielding to any other. The provision that the telephone and telegraph lines shall not incommode the public in the use of the street, in section 3461, does not help the defendant. The inconvenience must be determined when the enjoyment of the franchise is entered upon. After going is a true and correct copy of an order made by the said court on the 12th day of February, 1890, Min. 564.

Witness my hand and the seal of said court, at Cincinnati, this 14th day of February, A. D. 1890.

[SEAL.] JOHN B. PEASLEE, *Clerk*.
By R. H. BECHT, *Deputy*.

MISCELLANEOUS.

In the suit of the Wisconsin Telephone Co. *vs.* the Sprague Electric Street Railway Co., operating at Eau Claire, Wisconsin, for an injunction, Judge Bundy, on January 29th, refused to grant the application of the plaintiff.

At Torrington, Ct., the suit of the Southern New England Telephone Co. against the Torrington Electric Light Co., has been withdrawn, an amicable settlement having been made. The electric light company recently signed a telephone contract, made all its circuits metallic and parallel, and the plaintiff withdrew the suit and paid the costs.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From January 14 to February 11, 1890 (inclusive).

Alarms and Signals:—*Draft Annunciator for Mines*, W. Bullock, 419,312, January 14. *Automatic Fire Alarm*, E. Wider, 419,902. *Alarm*, J. Catz, 419,924, January 21. *Electric Fire Alarm System*, J. Speicher, 420,173. *Ocean Signal*, W. Thompson and A. Gartner, 420,217. *Electric Signal*, J. D. Taylor, 420,256, January 28. *Burglar Alarm*, N. M. Powell, 420,697. *Electrical Recording Instrument*, F. B. Wood, 420,850. *Method of Electrically Recording Signals*, same, 420,851. *Apparatus for Electrically Recording Signals*, same, 420,852. *Electric Time Alarm and Indicator*, C. A. Randall, 420,890, February 4. *Electric Compound Push*, J. F. Wollensak, 421,340, February 11.

Clocks:—*Electrical Clock*, A. R. Jones, 419,776, January 21.

Conductors, Conduits and Insulators:—*Insulator for Electric Wires*, I. P. Cornog, 419,642. *Screw Press for Insulators*, J. Pease, 419,875. *Electrical Conductor*, H. H. Carpenter, 419,923. *Insulating Pipe Joint*, G. M. Lane, 419,962, January 21. *Insulating Casing*, J. A. Seely, 420,171. *Gas-Pipe Insulating Device*, E. W. Rice, Jr., 420,391, January 28. *Staple for Electrical Conductors*, L. Stieringer, 420,635. *Insulating Compound*, J. B. Williams, 420,648. *Machine for Covering Wire, &c.*, F. E. Davis, 420,777, February 4. *Conduit for Electric Cables*, W. P. Tyler, 421,088, February 11.

Distribution:—*Electric Transformer*, E. Thomson, 420,396, January 28. *System of Generators*, A. G. Waterhouse, 420,924, February 4. *Transmission of Power by Electricity*, E. W. Rice, Jr., 421,193. *System of Distribution for Alternating Currents*, E. Thomson, 421,208, February 11.

Dynamos and Motors:—*Electric Motor*, S. C. C. Currie, 419,245, January 14. *Electric Commutator*, L. Gutmann, 419,660. *Dynamo and Motor*, same, 419,661. *Electric Commutator*, same, 419,662. *Method of Producing Alternating Electric Currents*, same, 419,663. *Alternate Current Motor Regulator*, same, 419,664. *Thermo-Dynamic Motor*, C. W. Weiss, 419,805. *Electric Motor*, Le R. S. White, 419,808, January 21. *Electric Motor and Regulator therefor*, E. A. Sperry, 420.117. *Regulator for Dynamos*, J. J. Wood, 420,138. *Governor for Dynamos or Motors*, A. G. Waterhouse, 420,338, January 28. *Regulation of Electric Motors*, L. W. Serrell, 420,469. February 4. *Regulator for Dynamos*, E. Heymann and F. W. Heymann, 421,048. *Starting Switch for Electric Motors*, W. A. Anthony, 421,090. *Motor for Electric Regulating Apparatus*, F. Ross and A. Franzen, 421,195. *Commutator for Dynamos, Motors*, etc., G. H. Alton and W. O. Wakefield, 421,222. *Collecting Contact for Electric Machines*, A. Schmid and E. C. Means, 421,320, February 11.

Galvanic Batteries:—*Galvanic Battery*, W. Burnley, 419,633; L. T. Stanley, 419,730; W. E. Irish, 419,774, January 21. J. F. Mehren, 421,081. *Electric Battery*, E. M. G. Hewett, 421,169, February 11.

Lamps and Appurtenances:—*Hood for Electric Lamps*, D. A. Culman, Jr., 419,186. *Shade for Incandescent Electric Lights*, J. H. Huber, 419,524. *Socket for Incandescent Lamps*, C. H. Lawton, 419,617, January 14. *Electric Lamp*, S. B. Cobb, 419,829, January 21. *Incandescent Lamp Socket*, H. Lemp, 420,077. *Electric Arc Lamp*, C. E. Scribner, 420,109; R. Schefbauer, 420,314. *Incandescent Lamp-Socket*, M. J. Wightman, 420,370, January 28. *Electric Lamp Adapter*, J. Stewart, 420,704 and 420,706. *Filament for Incandescent Lights*, R. Langhans, 420,881, February 4. *Cut-out for Incandescent Lamps*, E. Thomson, 421,207, February 11.

Measurement:—*Method of Making Electrolytic Meters*, A. E. Kennelly, 419,264. *Meter for Alternating Electric Currents*, O. B. Shallenberger, 419,367, January 14. *Electric Meter*, W. F. Smith, 420,214, January 28. J. D. Bishop, 420,762, February 4.

Medical and Surgical:—*Portable Faradic Battery*, L. T. Stanley, 419,731, January 21. *Therapeutic Magnet*, T. H. Hicks, 420,300, January 28. *Electric Belt*, A. J. Sheffield, 420,740. *Electro-Magnetic Abdominal Support*, M. E. Thomas, 420,840, February 4.

Metal Working:—*Electric Soldering Iron*, W. M. Miner, 421,185, Feb. 11.

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EXPIRING PATENTS.

Patents relating to Electricity which become Public Property in March, 1890.

Reported for the ELECTRICAL ENGINEER, by F. B. Brock, *Patent Attorney*, 639 *F street, Washington, D. C.*

Multiple Telegraph, M. Galle, 136,369, March 4, 1873. *Duplex Telegraph*, J. C. Wilson, 136,400, March 4, 1873. *Annunciator*. Shawk & Storer, 136,465, March 4, 1873. *Annunciator*, W. Humans, 136,518, March 4, 1873. *Electrolysis Apparatus*, I. Adair, Jr., 136,634, March 11, 1873. *Duplex Telegraph*, J. B. Stearns, 136,873, March 18, 1873. *Duplex Telegraph*, J. B. Stearns, 136,874, March 18, 1873. *Telegraph Key*, J. B. Stearns, 136,875, March 18, 1873. *Relay and Sounds*, J. B. Stearns, 136,876, March 18, 1873. *Electric Gas Lighting*, L. B. Moody, 136,930, March 18, 1873. *Printing Telegraph*, C. J. Wiley, 137,117, March 25, 1873.

[Drawings and specifications of any patent will be furnished by Mr. Brock at cost, 15 cents each.]

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

New England Editor and Manager, A. C. SHAW, Boston, Mass.
Western Manager, W. F. COLLINS, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada.	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. IX. NEW YORK, APRIL 2, 1890. No. 100

All the elements whose aid man calls in will sometime become his masters, especially those of most subtle force. Shall he, then, renounce steam, fire and electricity, or shall he learn to deal with them?—Emerson.

A PARTING WORD.

MORE than five years ago, at the earnest solicitation of many friends interested in the advancement of electrical science, the undersigned, not without considerable reluctance, consented to assume the editorial management of this journal. An opinion was entertained, which has been amply justified by results, that there existed in this country an almost wholly unoccupied field for a publication which should aim to devote itself more especially to the scientific and professional than to the distinctively commercial aspects of the electrical industries; which should constitute a vehicle for the publication and discussion of important professional papers, and which should present from month to month a well-digested record of the progress of theoretical and applied science in this department throughout the world. It must be left for others to judge what measure of success may have at first attended the undertaking, but it has for some time been apparent that by reason of the unparalleled and unforeseen expansion of the field of electrical work all over the world, the programme originally laid out could not possibly be fulfilled, to the acceptance either of the patrons or of the management of THE ELECTRICAL ENGINEER, unless arrangements could be made to issue it more frequently, a step which was felt to have become imperative, and which would have been taken long ago but for the added burden of labor which circumstances rendered it impossible for its conductors to assume. In retiring from the editorial chair, the undersigned desires to express his sincere thanks to the appreciative contributors, advertisers and readers, who have so effectively aided him in his efforts to carry out his design. He would also add, that he esteems himself peculiarly fortunate in having been able to place THE ELECTRICAL ENGINEER in the hands of editors so widely and so favorably known to the profession throughout the world as are Messrs. Martin and Wetzler. FRANKLIN LEONARD POPE.

GREETING.

WITH its 100th number THE ELECTRICAL ENGINEER celebrates its century of months by appearing for the first time as a weekly journal. It will henceforth issue and be dated Wednesday of each week. The new organization of the editorial and of the business staff under which THE ELECTRICAL ENGINEER will be conducted is fully set forth elsewhere in this issue. The preliminary announcements of the enlarged plans of this journal have met with such general and cordial approval on all sides as to confirm beyond question the judgment of the proprietors in undertaking them.

The present issue further distinguishes its serial number by containing, with happy coincidence, exactly 100 pages. Following the last previous issue by a month, the accumulation of matter has rendered necessary a somewhat larger amount of reading in this than our subscribers and friends might naturally expect every week—for the present.

In assuming the office of president of the corporation organized as THE ELECTRICAL ENGINEER, the subscriber desires to join with Mr. Pope in expressing his sense of gratification in seeing the editorial chairs occupied by Mr. Martin and Mr. Wetzler. GEORGE M. PHELPS.

A LEGAL MONSTROSITY.

WE have never felt any hesitation in saying, as we have done on more than one occasion, that the provision in the Federal Statutes by which the duration of a prior foreign patent is permitted in any way to affect the validity or life of a domestic patent, was a relic of barbarism which ought to be summarily swept away. In THE ELECTRICAL ENGINEER of March, 1889, we expressed the opinion that under the doctrine announced by the Supreme Court in the Bate decision, the forfeiture of foreign patents for non-payment of taxes would be likely to affect adversely a subsequently issued domestic patent, a view in which we were afterwards supported by Justice Thayer, in his opinion in *Huber* v. *Nelson Mfg. Co.*, two months afterward. In the May number of THE ELECTRICAL ENGINEER, commenting further upon this matter we said :—

> We are forced to admit that it would not be an unprecedented circumstance, if the next time the question comes up, the Supreme Court should decide it exactly contrary to the logical deduction which necessarily follows from the text of its opinion in the Bate case.

This is exactly what the Supreme Court has now done, as will appear from its decision just rendered in *Pohl* v. *Anchor Brewing Co.;* the main points of which are given elsewhere in this issue. Section 4,887, has in fact been knocked back and forth across the arena so many times that it has become, so to speak, dilapidated and frayed out at the edges. The variety, no less than the inconsistency, of the several interpretations which have been put upon it by learned jurists would afford a subject of curious interest merely, but for the dependence of vast commercial interests upon the final result—if there ever should be a result which could be so considered. Not the least singular fact in connection with these contradictory decisions, is that the more important of them have been written by one and the same justice. A comparison of three of these decisions is calculated to throw a shade of doubt upon the assertion of Blackstone that "the law is the perfection of human wisdom."

U. S. Circuit Court.	*U. S. Supreme Court.*	*U. S. Supreme Court.*
August 29, 1888.	**January 21, 1889.**	**March 24, 1890.**
GRAMME Co. *v.* ARNOUX.	**BATE REFRIGERATING Co. *v.* HAMMOND.**	**POHL *v.* ANCHOR BREWING Co.**
Justice BLATCHFORD.	Justice BLATCHFORD.	Justice BLATCHFORD.
It is also contended by the plaintiff that the Austrian patent, though granted for the duration of one year on its face, was really a patent for 15 years. It might have been prolonged year by year, or otherwise, for five years beyond December 30, 1880. But it was not prolonged beyond that date, and at most it cannot be regarded as a patent which, when granted, had a longer term to run than till December 30, 1880. even if it could be considered as a patent having when granted a longer term to run than one year. *A capacity of being prolonged so as to have a duration of* 15 *years is not equivalent to having a term of* 15 *years, when the patent is granted for one year and then is prolonged so as to expire at the end of* 10 *years.* * * The Austrian patent conferred on the patentees an exclusive privilege. *It was the manifest intention of Section* 25, *of the Act of* 1870, *that the exclusive privilege under the patent here should expire with the exclusive privilege granted abroad to the same inventor having the shortest term.* As the Austrian patent expired at the latest, on December 30, 1880, and before this suit was brought, and No. 120,057 *continued to exist no longer*, there was no ground for this suit in equity when it was brought.	Section 4,887, of the Revised Statutes, provides that "every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than 17 years." *These provisions of the Act of* 1870, and of the Revised Statutes, *mean that the United States patent shall not expire so long as the foreign patent continues to exist*. not extending beyond 17 years from the date of the United States patent, *but shall continue in force*, though not longer than 17 years from its date, *so long as the foreign patent continues to exist.* Under Section 4,887, although, in the case provided for by it, the United States patent may on its face run for 17 years from its date, *it is to be so limited by the courts, as a matter to be adjudicated on evidence in pais, as to expire at the same time with the foreign patent*, not running in any case more than the 17 years; but, subject to the latter limitation, *it is to be in force as long as the foreign patent is in force.*	*There is nothing in the statute which admits of the view that the duration of the United States patent is to be limited by anything but the duration of the legal term of the foreign patent in force at the time of the issuing of the United States patent, or that it is to be limited by any lapsing or forfeiture of any portion of the term of such foreign patent, by means of the operation of a condition subsequent, according to the foreign statute.* In saying that "every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent," the statute manifestly assumes that the patent previously granted in a foreign country is one granted for a definite term; and its meaning is, that the United States patent shall be so limited as to expire at the same time with such term of the foreign patent.

In view of this record, we respectfully submit, that instead of making any further efforts to discover the intentions of the maladroit who inserted this provision in the patent law, the Supreme Court be relieved from further consideration of it, by its immediate repeal.

EFFICIENCY OF ALTERNATING APPARATUS.

EVER since the alternating current apparatus entered the field of electric distribution, a brisk controversy has been carried on as to the efficiency of that class of apparatus as compared with the continuous. Though much acute reasoning was brought to bear on the subject, there has up to the present been little reliable data of an independent source available for a practical comparison, and that in existence related merely to individual devices in connection with the alternating system. Thanks to the labors of Dr. Duncan and Mr. W. F. C. Hasson, however, we are now placed in possession of data which is undoubtedly reliable, and which, while giving the tests of all the individual apparatus of the alternating system, includes the efficiency of the system as a whole from the dynamo pulley to the lamp. The analysis of the results would seem to show that the principal loss encountered is to be detected in the armature of the dynamo, and this fact, we believe, is now well recognized by the manufacturers of alternate current apparatus, so that improvement of the kind needed may be looked for at no distant date, embodying among other changes the application of the toothed armature instead of the plain cylindrical as heretofore employed. The converters are shown to be quite efficient, and the curious relation is brought out that the loss in their cores is nearly constant for all loads. It is this constancy of relation that, as Mr. Tesla pointed out in the discussion before the American Institute of Electrical Engineers, may ultimately establish the correctness of the hypothesis advanced, that in reality there is practically no loss due to hysteresis, and that the changes of magnetization represent a charging and discharging of molecular energy without entailing an actual expenditure of energy. The losses, then, must be due to eddy currents principally, and the remedy is obvious. Dr. Duncan, in the discussion, also gave expression to his views on the application of the system of distribution, alternating and continuous, which we think are now being generally adopted by intelligent electrical engineers. According to these, the circumstances of each case must dictate which is the more economical to apply, and hence no hard and fast rule can be given. Where the density of population permits of it, the low-tension system of distribution is apparently the more economical; but where the consumers are scattered, as they are in a vast number of towns and cities, and at such distances from the station that direct working would involve too great a loss, the converter system is eminently applicable. Dr. Duncan goes further and gives it as his opinion that the best results could be obtained by a combination of both systems in a central station which would thus be able to accept all the business offered to it independent of distance. That these views are sound is evidenced by the fact that they have already been put into practical operation in a few instances by men of leading, and we cannot but believe that in this direction will be found the settlement of a long-waged and earth-shaking controversy in the industrial domain of electricity.

STORAGE BATTERY LITIGATION.

THE decisions in the various suits bearing on the validity and ownership of important inventions in electricity are now following one another in such rapid succession that the time cannot be far distant when the exact status of various important and fundamental inventions will be finally established. This is notably so in the case of the storage battery. Following close upon Judge Coxe's decision awarding to Faure the patent for the application of the active material to a storage battery plate in the form of paint, paste or cement, comes another by the same judge, in which the broad principle of the application of active material to such a plate is awarded to Mr. Brush. The decision, though of considerable length, will nevertheless bear perusal as it disposes of a number of points which are of general and even vital interest to inventors. Thus Judge Coxe regards "absorptive" and "active" material as applied to a storage battery as synonymous terms, and holds the two patents covering each individually to be equivalents of each other; and hence the anomalous condition is brought about that two patents have been issued for the same thing. In the present instance, no particular harm has been done, but Judge Coxe raises the question as to the harm that might have been done had one of these patents been assigned to another party. The expired Italian patent of Brush was brought into evidence to show the invalidity of the United States patent, but on this point Judge Coxe gave the benefit of the doubt as to the identity of the two to Brush, and held the Italian patent not to cover the same points as the one in litigation. Even if Judge Coxe had decided otherwise, the recent decision of the Supreme Court, commented on elsewhere, would have sustained Brush in his rights, so that this point may be considered as definitely settled. With the decision in Mr. Brush's favor, and in the absence of an appeal, it gives him practically the control of the storage battery in this country, and as a working arrangement between him and the Julien company has, it is understood, been effected, some important developments may be expected in the near future.

Alternating Arc Lights.

We present to our readers in this issue a complete description of the new Westinghouse arc light system, which has been the subject of much curiosity and not a little comment in electrical circles. In this system the Westinghouse company is evidently carrying out to its logical conclusion the opinions held by it in regard to the alternating incandescent system, according to which the consumers' apparatus, the lamp and accessories, are entirely dis-disconnected from the high tension circuit. The self-regulating qualities of the machine due to the peculiar construction of the armature and winding are of particular interest and show the remarkable flexibility as well as applicability of the alternating current to particular cases. The record of power tests of one of the large machines of this type will also arrest the attention of station managers. As will readily be observed, the details of the system have been carefully worked out, and the results are such as to justify the expectation that it will be widely introduced.

Predictions of a "Trust."

Rumors are current in electrical circles, and even in the daily press, of measures on foot among leading electrical manufacturing companies preparatory to further amalgamation of interests, and the consequent elimination from the situation of a great part of the prevailing competition for business as well as of much patent litigation. Predictions are indulged of the eventual formation of a great electrical trust to absorb all the prominent electric light and power interests. Further consolidations may reasonably be looked for in the near future, but it seems to us very unlikely that a comprehensive electrical trust will be seriously undertaken by even the most daring of the able administrators now controlling the affairs of the few very large companies. The complexity of the conditions to be dealt with in organizing and maintaining an electric light and power trust is very great, incomparably greater than in the case of such industries as the manufacture of oil, sugar, white lead and the like. No combination of patents would sustain a general monopoly for any certain period. The common ground now open to electrical manufacturers, so far as regards patent control, is spacious enough to entice capital into new enterprises, many of which are constantly springing up in all directions. Moreover, the possibility of new and radical discovery or invention in the production or distribution of electricity adds an incalculable element to the situation far greater than obtains in other industries. With or without patent control, combinations or trusts, it is safe to say that nothing can be surely relied upon for permanent success in the field of electrical business, whether by one organization or by many, without a ruling policy of sound engineering, stable construction in all details, careful economy and moderate profits. The present competition among the principal companies brings about such a policy for the most part, and has perhaps moderated the profits too greatly for the satisfaction of share holders.

In Season and Out.

Tempted by the early mildness of the spring, an enterprising electric motor agent in a city not many miles from New York prepared a batch of tasteful fan outfits a few weeks ago, and began to distribute them in a number of stores, restaurants, etc., where their cooling zephyrs would be best appreciated. The very day he sent them out the weather changed, and the men entrusted with the work put up the motors with numbed fingers, while there raged outdoors the heaviest snow storm of the year. Such an incongruity of situation might well have dampened the ardor of any man, but our motor friend went on, and the humor of the thing so struck many of his customers that instead of waiting thirty days, they sent him in their checks at once, congratulating him upon his remarkable display of zeal and enterprise. An episode of this kind carries with it the moral that it is never out of season to sell and install electrical apparatus.

The Edison-Lalande Battery.

Though Mr. Edison has devoted most of his time for the last 10 years to the perfection of apparatus for the generation and utilization of heavy electric currents, he has recently turned aside to take up a branch which has by many been neglected in these later days. The primary battery has, indeed, come to be considered much in the nature of a necessary evil, and perhaps not seldom justly so. But being still a necessity in a vast number of situations, it merits attention and ought not be considered slightingly. With these sentiments in mind, evidently, Mr. Edison has taken up a type of battery which undoubtedly possesses some marked characteristics that for certain purposes makes its application advantageous notwithstanding its comparatively low E. M. F. The improvements effected in the cell over the form as originally brought out by Lalande, will go far towards introducing it in places where its application was formerly impracticable.

The Senate Committee's Report.

It must be a matter of satisfaction to all who are interested in the welfare of the electric light and power industry that the New York Senate Investigating Committee, charged with the duty of reporting on the relative dangers of overhead and underground wires, and high and low tension currents, has submitted a quite reasonable and moderate statement of the case. Where a body of this kind is so endowed with the ability to do mischief, it is cause for congratulation that it cultivates rather the opportunities of allaying public fears and of presenting the evidence in a straightforward, re-assuring manner. In the main, the report which we print elsewhere is excellent. The chief point to which we would take exception is the proposition that no overhead electric railway wires shall be run in cities of over 125,000 population. The direct current on such wires of 500 volts is not dangerous to life, and with proper construction does not endanger property. Should the proposed limitation be adopted, however, there would, we think, be a very rapid development of storage car work and of conduit systems, and this, certainly, would be something that could be viewed optimistically.

Passengers Per Car Per Month.

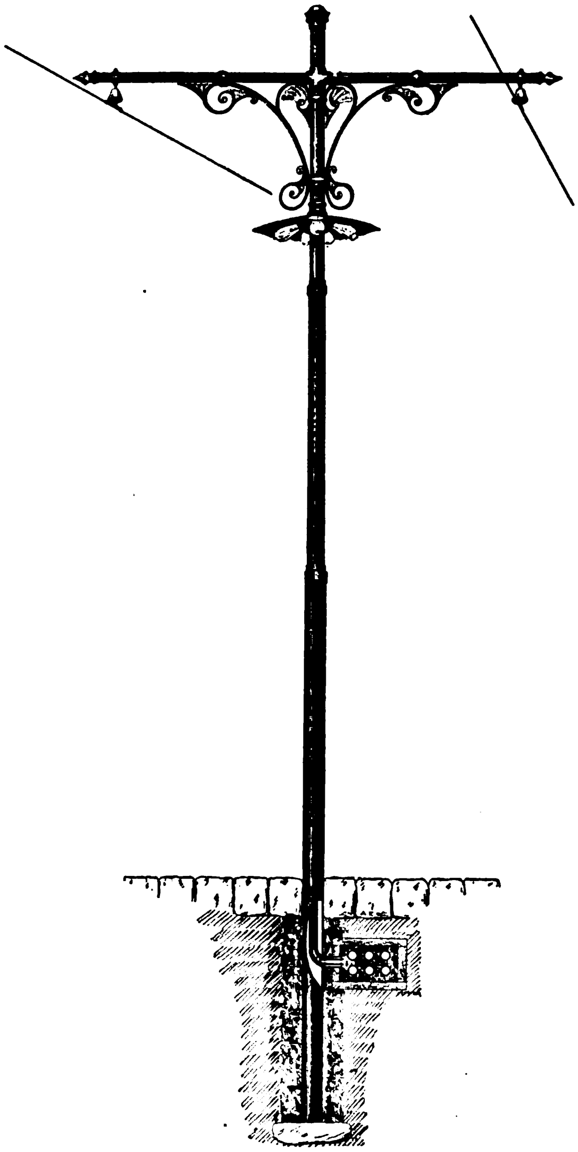
The question is often asked : "How many passengers do street cars carry ?" On this point there has been no little figuring and conjecture; yet like most things of the kind it should be easily determinable. Looking into the matter not a great while ago, the Thomson-Houston Company found that 9,000 passengers per car would be a fair average for good, ordinary work. This figure was arrived at from reports on a number of their electric roads operating only from two to ten cars. This would make 300 passengers a day for a month of 30 days, and would represent, say, $15 daily in fares. We would be glad to hear from some of our readers on this item of receipts, which is naturally a vital one to managers contemplating a change of motive power or to capitalists starting a new road. It has been estimated that the electric roads of the country are carrying now about 150,000,000 passengers a year. Upon the basis of 9,000 per car per month, and 2,000 cars in operation this summer, electric roads during 1890 will be carrying passengers at the rate of $16,000,000 per annum.

Electricity and Social Science.

It is interesting to note the manner in which the leaders of thought to-day look to electricity for a solution of many of the problems that they grapple with hopelessly or despondingly under the old familiar conditions. One hardly expects their fond anticipations to be fully realized, but there should be encouragement for electricians and electrical engineers in this recognition of them as the vanguard of the social and industrial influences that make for progress and a higher evolution of human existence. In fact they are under the responsibility of having to prove almost more than any other body of men that science, invention and discovery tend to promote the welfare of modern society. In this issue will be found a paper which, dealing with electric railroads as the latest practical development of electric arts, endeavors to set forth the various advantages that may be derived from this form of locomotion in towns and cities. Perhaps there is not much that is new in the paper, nor much that lies far below the surface, but it may be helpful in suggesting to the public some of the benefits it will secure, and in supplying the electric railway engineer and promoter with arguments for his campaign.

NEW SPRAGUE RAILWAY UNDERGROUND WORK.

When electric railway work was first undertaken, the number of cars and the distance covered were so small that a single conducting wire overhead sufficed both as the feeder and trolley wire, or working conductor. As the number of cars operating upon a single road, as well as the distance of the lines radiating from the generating station, increased, it became apparent that the drop and the loss in the line consisting of a single trolley wire were too great. To increase the size of this wire, however, involved a number of difficulties, and, as a result, the practice was inaugurated of running what are known as main conductors in connection with the trolley wires which are designated the working conductors. These main conductors of heavy wire are usually attached to the same poles as the trolley wires, and are connected to the latter at short intervals. At various points also, in the best designed systems, they are connected to heavy feeders radiating from the central station, so as to maintain uniform potential on the line.



Electric Railway Pole and Conduit Connection.

Essential as these main conductors are to the proper operation of the system, their presence overhead, has given rise, on account of their necessarily large size, to some objections, and it is with the purpose of removing these that the Sprague Electric Railway and Motor Co. has designed a system in which only the trolley wires appear above ground, all other auxiliary conductors being placed underground.

The accompanying engraving shows in general the plan which it is proposed to adopt in future work of this kind in densely populated districts.

The work intended contemplates the placing of poles for carrying double trolley wires between double tracks of the street railway. The mains and feeders are to be carried in insulated conduits placed underground. The subfeeder wires between the main line and the trolley line, will be carried up the interior of the pole in an insulated or interior conduited pipe. Another set of wires for lights will also be supplied from a separate switching circuit running direct from the station and connected with all the series of lights on the poles. The conduits employed will probably be those manufactured by the Interior Conduit and Insulation Co. The details of this system give a very excellent form of construction for electric street railways making the overhead system entirely unobjectionable, and furnishing also the light for the streets through which the railway passes, the control of the lights being from the power station direct.

THE NEW WESTINGHOUSE ALTERNATING ARC LIGHTING SYSTEM.

As our readers may be aware, the Westinghouse Electric Company have for some time past been engaged in working out a system of arc lighting with alternating currents, and the results obtained have been such that the system is now ready to be placed in commercial operation. One of the first systems of arc lighting, which was commercially exploited, it will be remembered, was that of Jablochkoff, who as far back as 1876 employed his well known candle in direct circuit with a dynamo machine which generated alternating currents. The present system, however, is designed to be operated generally in connection with converters.

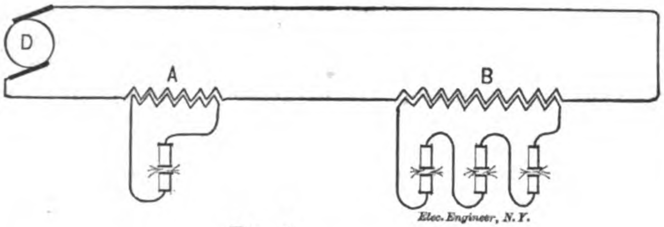


FIG. 1.

The system, broadly speaking, consists in operating a constant current main circuit which passes through converters suitable for the number of lamps to be operated at any one point. The diagram, figure 1, shows this method of operation in outline. Here the dynamo, D, generates a constant alternating circuit which, passing to the primaries of the converters, A and B, generates in each the current sufficient to operate one, three or more lamps, as the case may be. The system has been worked out in a very complete manner both as regards the dynamo, the lamps and accessories.

Beginning with the dynamo, which is illustrated in the engraving, figure 2, it will be seen to resemble very closely the Westinghouse alternating incandescent machine, but its distinguishing feature is to be found in the construction of the armature. The latter is shown in perspective in figure 3, and in longitudinal and transverse sections in figure 4. It will be noted that in this case the armature coils are not, as heretofore, in the shape of flat coils placed on the periphery, but consist of oblong coils which are wound separately as shown in figure 5, and then by means of the clamping tool, figure 6, are clamped in position around the cores of the armature projections which are provided with overlapping teeth. After the coils have been placed in position the spaces between the teeth are filled out with

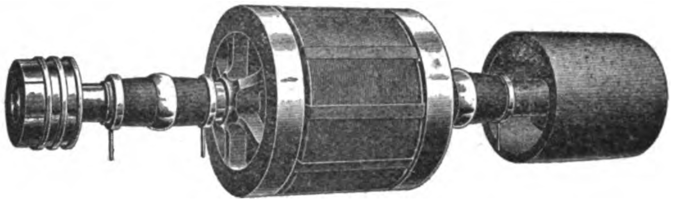


FIG. 3.

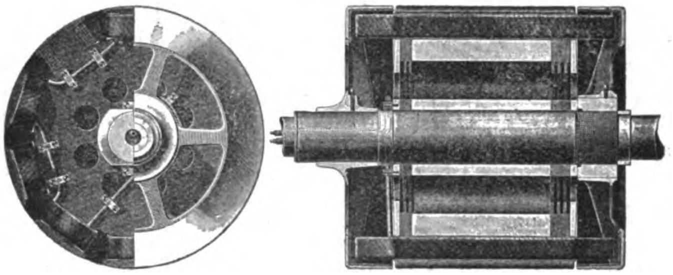
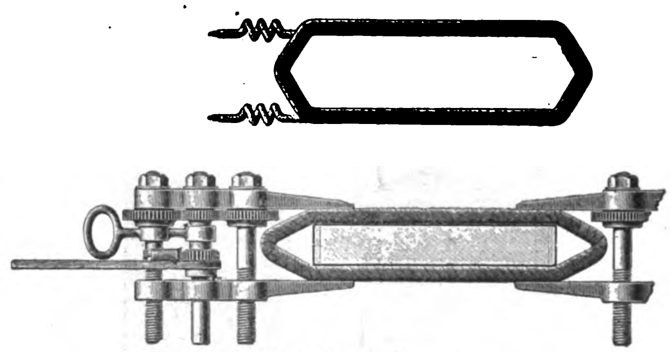
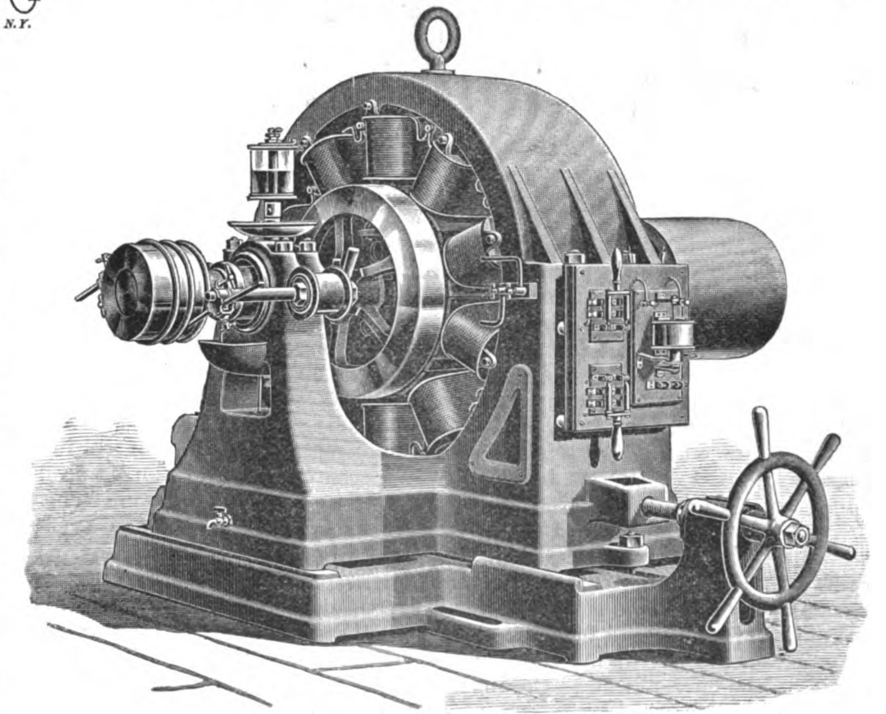


FIG. 4.



FIGS. 5 AND 6.



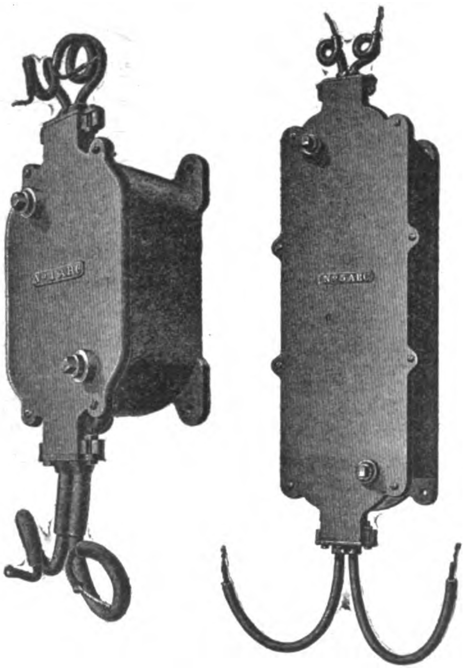
THE WESTINGHOUSE ALTERNATE CURRENT ARC MACHINE.

wooden wedges which are dove-tailed and slid in from the side, so that no further fastening is required to keep the coils or the wedges themselves in position.

The peculiar construction of the armature with the overlapping teeth has the effect of maintaining the current constant at all loads, so that there is no regulating apparatus whatever required for that purpose.

The armature is built up of thin wrought-iron sheets stamped out to the required shape and the teeth are so designed, and are of such length, that they slightly overlap the distance between two consecutive pole pieces, so that one tooth is not out of the field of any one magnet before another enters that field.

At the side of the dynamo in figure 2, there will be noted an apparatus consisting of a solenoid with a single core. It is a short circuiting apparatus, and its object is to protect the machine from the results of a break in the line. In the continuous current machine a break in the line is generally followed by the cessation of current in the armature when a series machine is employed; but in this system a break in the external circuit causes the generation of a heavy current in the armature, which, if not prevented, would eventually cause its destruction. To avoid this the apparatus shown is employed and its function is to short circuit the armature. By this means the counter electromotive force generated in the armature is such as to cut down the heavy current to the normal strength, so that no dangerous heating of the armature coils can take place. The apparatus is so constructed that an excess of electromotive force generated in the armature, such as would be caused by a break in the line causes a spark to pass between two points; this allows sufficient current to pass to energize the solenoid which pulls up its core and makes contact between two points that short circuit the armature. Normally the distance apart of these points is so regulated that any excess of current beyond 12 amperes causes the spark to jump and effect the short circuiting.



FIGS. 7 AND 8.

There is still another safety device of the same nature which consists of two metal points placed opposite each other on the armature shaft and connected respectively to the collector rings. Upon the current exceeding a certain value the spark formed between these two points causes a short circuiting of the machine and a consequent cutting down of the current due to the increased self induction.

The machines now built and in course of construction vary in capacity from 25 lights to 240 lights, and the table on page 152 shows their various sizes and capacity. It will be noted that the speeds of these machines are considerably lower than those employed in the incandescent system and that the number of alternations per second is also far below that of the former, the average number approximating 7,500 alternations per minute, as compared with 16,000 for the incandescent machines. The machines Nos. 2 and 3 are provided with two sets of windings connected to two pairs of collectors, so that two independent circuits can be run from one machine.

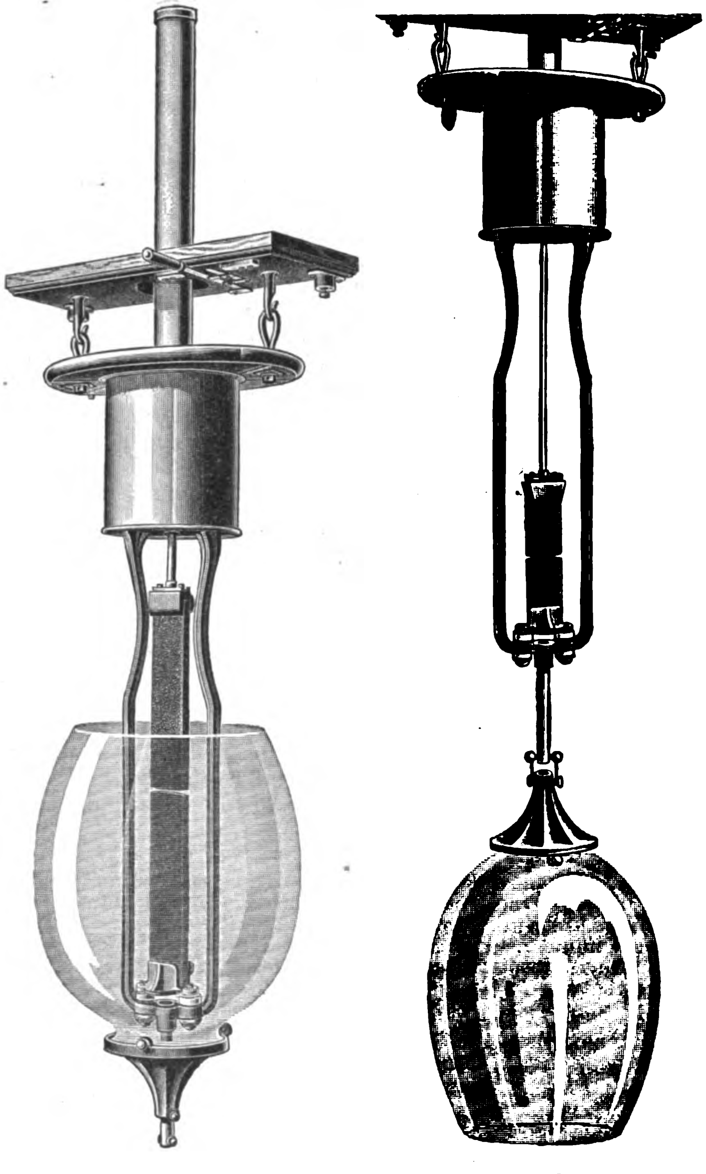
Coming now to the apparatus intermediary between the dynamo and the lamps, we find it to consist of converters which do not, of course, differ in principle from those used in connection with the incandescent system of distribution; but for this particular purpose converters of a peculiar construction are in some instances desirable. In ordinary incandescent systems the primary and secondary of the converter are usually so designed that the ratio of reduction of potential between them is comparatively a high one, usually in the neighborhood of 20 to 1. In this system, however, a series of converters of various capacities are designed in which the ratio of the primary to the secondary is as 1 to 1, and in others as 1 to 3, as exhibited in the table, on page 152, of the various sizes constructed. Two sizes of these converters are illustrated in figures 7 and 8. The windings in the 1 to 1 converters are evidently identical for the primary and secondary. Though on first consideration this might be considered a curious condition, the reason therefor will become apparent when it is considered that by the employment of such converters no greater potential is admitted to a building in which there is one lamp, for instance, than is required for that particular one, and leaving the same perfectly safe to be handled, as the potential required for each lamp does not exceed 50 volts.

The lamps employed in connection with this system are of two general types known as the long and short lamps, and designed respectively for outdoor and indoor use. The long lamp is shown in figure 9, as it appears when trimmed, and figure 10 shows the same ready to be trimmed, a very simple device being attached by which the globe can be conveniently hung from the lamp while the operation of trimming is proceeding. The short arc lamp, which does not differ in its principle of construction from that just described, is designed for indoor use and is usually provided with white globes.

The distinguishing feature of these lamps consists in the fact that they are designed to burn carbons whose life approximates to 40 hours in the case of the long lamp, and to a somewhat shorter period in the case of the short lamp. Thus, in the long lamps two carbons are employed, the dimensions of which are 9½ x 2 x $\frac{7}{16}$ inch. Both carbons are of the same dimensions, as the alternating currents have an equal action on both. In the short lamp the length of the carbon is reduced to six inches. The mechanism of the lamp is very simple and consists in a rack movement which is regulated by a solenoid in the main circuit and by another of high resistance which is placed in shunt to the arc. Both of these are provided with cores built up of bundles of fine wire so as to avoid heating and to increase their sensitiveness. The lamps may be operated in connection with electric meters and in this way the customer may control individually the time during which the lamp shall burn and at the same time the charge which is made for the same. The employment of carbons lasting in the neighborhood of 40 hours also obviates the necessity of a daily inspection and trimming of the lamp. The lamp when burning is accompanied by a slight humming noise, which, however, is hardly noticeable, and which we understand will soon be overcome.

There are several excellent accessory devices employed with the system, one of which, a double safety cut-out, is illustrated in figure 13. This consists of the usual strips of fusible metal but, in addition, the points which they span are shunted by a fine German silver wire. It frequently happens that upon the fusing of the usual safety strip, an arc forms at the break which is apt to travel backward and burn the contacts and thus ruin the entire device before the arc is broken. By employing the German silver shunt around these points the fusing of the fusible strip immediately sends the current through the shunt which at once fuses, breaking into small pieces and forming directly a break of six inches between its terminals—a distance which the arc is incapable of following.

Our readers will no doubt be interested in a series of tests which have been made on this system showing its efficiency under various conditions and for that purpose we add below a table giving the results of a test carried out at the works of the Westinghouse Electric Company in Pittsburgh. These tests were made on a No. 2, 30 ampere machine operating 120 lights. The engine was of the Westinghouse single acting two cylinder type, the diameter of the cylinder being 14½ inches and the length of stroke 30 inches. The curves shown in Fig. 14 represent graphically the results given in the table. From these it will be seen that the machine at very light load has a comparatively low efficiency, but beginning with 40 lamps up to the full capacity the efficiency rapidly increases until at full load, it approximates 87 per cent. and the energy per lamp required is .75 h. p. A number of these machines have already been put in practical operation in this city and others are in course of installation in Boston, Portland and a number of other cities.



FIGS. 9 AND 10—THE WESTINGHOUSE ALTERNATE CURRENT OUT-DOOR ARC-LAMP.

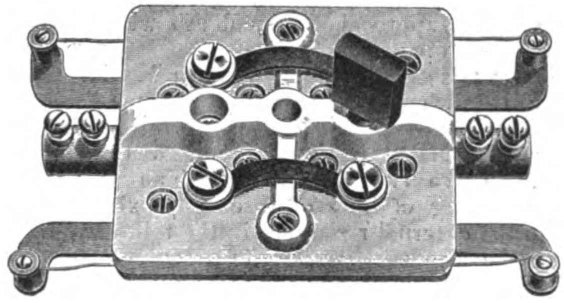


FIG. 13.

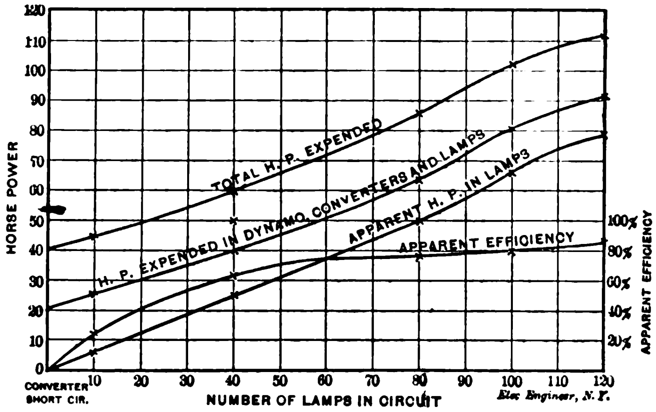
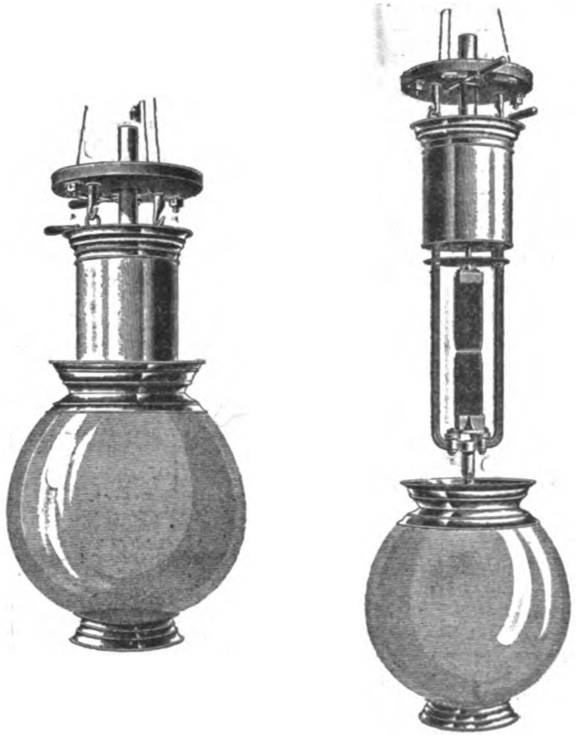


FIG. 14.



FIGS. 11 AND 12.

In further explanation of the action of the machine we may add that the regulation for constant current depends primarily upon the fact that the armature is wound with a sufficient number of turns to produce a high self induction, and consequently a lag in the current approaching 90 degrees when short circuited. According to a well-known law, the current lag, as related to the impressed electromotive force, is reduced by the introduction of resistance into the circuit, and approaches coincidence with the phase of electromotive force as its limit.

The magnetization of the field is so related to that of the armature that when an armature pole is opposite to a field pole and the magnetizing effects are in contrary directions the resultant magnetization is reduced to a very small amount. These two elements combine to produce an effective cutting of lines of force approximately proportional to the external resistance in the following way:

When the armature rotates with a high resistance in circuit the lag is small, and the maximum current flows in approximate coincidence with the maximum of electromotive force; that is, when an armature pole is in an intermediate position between two field poles. The direction of current is opposite to that in the field coils of the pole it is approaching. In other words, the maximum point in the current phase occurs about 90 degrees in advance of the coincidence of two poles of similar polarity.

A reduction of resistance in the work circuit causes a lag in the current phase, so that the maximum point is reached at an instant in time more nearly coincident with the opposition of similar poles; and when the armature coils are short circuited and the lag reaches its maximum, the magnetization of the armature pole occurs approximately at the time of its passage under a field pole of opposite polarity. Since the windings of the field and armature are such as to set up approximately equal magnetic potentials in opposite directions, the cutting of lines of force is now reduced to a minimum value sufficient to cause the flow of a normal current through the coils. The current characteristic of the machine can be made to approach as nearly to constancy as can the electromotive force characteristic of a constant potential dynamo with varying current.

Converters.

1 light, one to one (10 amp.); one to three (30 amp.)
3 " " " " " " "
5 " " " " " " "

Sizes and Capacity of A. C. Arc Dynamos.

	No. of Lights.	No. of Coils on Arm.	No. of Pole Pieces.	Speed.	Amperes.
No. 00	25	6	6	1275	10
No. 0	40	8	8	950	10
No. 1	60	10	10	760	10
No. 2	120	12	12	650	30 } 2 circuits
No. 3	240	16	16	480	30

SCHOOP ON ACCUMULATOR THEORIES AND MANUFACTURE.

At the meeting of the Chicago Electric Club, on March 3, Dr. Paul Schoop, of Zurich, Switzerland, read a paper on "A Theory of Accumulators." He combated the sulphate theory and advanced a view of his own. Speaking of an experiment with a palladium voltameter, Dr. Schoop made the following statement which gives an idea of his theory:

"We may say in short that the whole behavior of a palladium or of a platinum voltameter is in every way so similar to that of a lead accumulator that we would be at a loss to point out essential differences. The hydrogen is supposed to be held in the palladium, as, for example, mercury in copper or zinc, and physicists speak nowadays of an *alloy* of palladium and hydrogen. I now propose the following theorem: 'The charged kathode of a lead accumulator contains an alloy of lead and hydrogen, and this hydrogen-alloy is the true active material.' If platinum, palladium, mercury and iron combine with hydrogen, why should not lead do the same? Take a charged, so-called 'negative' plate out of an accumulator cell. After a few minutes vapors will rise from it and soon the plate will become so hot that the solid metallic frame will melt. Who can help remembering Faraday's platinum foil? Lead may be prepared in a most finely divided state, by reducing lead salts, say, chloride of lead or zinc, in an acid or salt solution; but this lead would not heat spontaneously as in the first experiment. We can easily see how the charged lead accumulator acts; the kathode contains hydrogen alloy and between it and the acidulated water there is a certain potential. The anode contains oxygen, however, not in a condensed state or as an alloy, and not firmly united, but in a chemical compound, namely, that dark, black, most highly oxydized peroxyde of lead. * * * Now what is our experience in manufacturing accumulators with pasted plates? The capacity of the cells depends directly upon the degree of fineness of the powder employed for the paste. Lead sponge obtained, for example, by heating tartrate of lead can absorb more hydrogen than can lead sponge obtained by reducing oxide of lead. The highest capacity is found in lead sponge in which all the particles are most finely divided within the largest space. If we press lead sponge under a high pressure, we find a decrease of its capacity, and if we finally press it into a solid plate of lead, we will have to commence again with the old Planté forming-process."

.... WE must depend for the rapid advancement of physical science upon the education of the masses. In this country, men devoted to science purely for the sake of science are, and must be, few in number. Few can devote their lives to work that promises no return except the satisfaction of adding to the sum of human knowledge.—*Professor W. A. Anthony.*

POWER TESTS OF WESTINGHOUSE ALTERNATING ARC SYSTEM.

LOAD.	Average Pressure per Square Inch Right Cylinder.	Average Pressure per Square Inch Left Cylinders.	Average Pressure, Both Cylinder.	Average Speed Rev's.	H. P. Indicated.	H. P. Neglecting Engine and Shaft.	Amperes in Lamp Line.	H. P. Per Lamp.	Apparent Watts in Lamp Line.	Apparent H. P. in Lamp Line and Apparent Efficiency.
Engine and Shaft........	6.85 lbs.	6.03 lbs.	6.44 lbs.	301.3	21.04	....	....	....	....	....
Dynamo and Exciter....	6.72	7.53	7.12	302.4	23.40	2.36	....	....	....	....
Dynamo, Short-Circuited	8.67	10.62	9.64	298.4	30.90	9.86	....	....	....	....
Dynamo, Short-Circuited through Converters....	11.45	13.49	12.47	300.0	40.56	19.52	....	....	....	....
Dynamo, Converters and 10 Lamps..............	13.25	14.57	13.91	297.8	44.9	28.85	10	2.38	4660	6.2 H. P. 26 %
Dynamo, Converters and 40 Lamps..............	18.12	20.3	19.21	291.0	60.6	39.56	10	0.989	18800	25.2 H. P. 63.7 %
Dynamo, Converters and 80 Lamps..............	25.9	28.4	27.15	288.8	85.1	64.06	10	0.801	37860	50.7 H. P. 79 %
Dynamo, Converters and 100 Lamps..............	31.32	33.13	32.22	290.5	101.5	80.46	10	0.805	49150	65.9 H. P. 82 %
Dynamo, Converters and 120 Lamps..............	35.2	36.9	36.05	285.4	111.5	90.46	10	0.754	58980	79.06 H. P. 87 %

THE EDISON-LALANDE BATTERY.

It is several years since the attention of electricians was drawn to a battery invented by M. Lalande, which at the time attracted considerable attention on account of its simplicity and other advantages, principal among which was its constancy of action and low internal resistance. Recently Mr. Thomas A. Edison has taken up this type of cell and after considerable experimenting has succeeded in developing it into a form such that it can be generally applied to a large variety of work.

The elements employed in the cell are zinc as the positive, and the black oxide of copper, Cu O, as the negative, the exciting liquid being a solution of caustic potash. The black oxide of copper is obtained by roasting copper turnings; the oxide in the form of a fine powder is then compressed into solid blocks which are held in position in the cells by means of a light frame of sheet copper; the latter also carries the terminals at its top, as shown in the accompanying illustration, Fig. 1, which represents the 300 ampere-hour cell. The copper oxide element of the cell is placed between two rolled zincs which are superficially amalgamated and are prevented from touching the negative element by vulcanite buttons and rubber bands. As in most batteries, action upon the zinc is greater near the top; hence the zincs are made slightly tapering with the thinner end at the bottom of the cell.

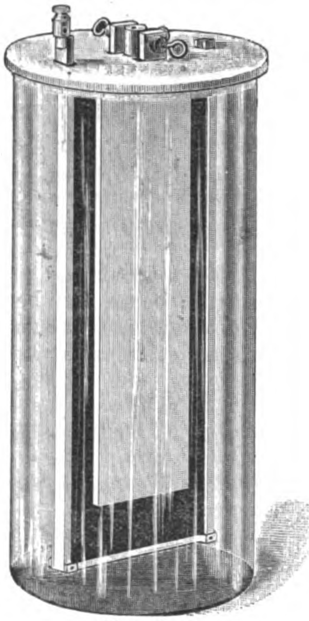


Fig. 1.

The solution employed in the battery consists, in the case of the 300 ampere-hour cell, of one pound of caustic potash dissolved in three pounds of water. The result of the action of the cell is to reduce the copper oxide to metallic copper, a double salt of zinc and potash being formed which goes into solution. This reduced copper is of great purity and can be re-employed by oxidizing it; and arrangements have been made by which the manufacturers undertake this work.

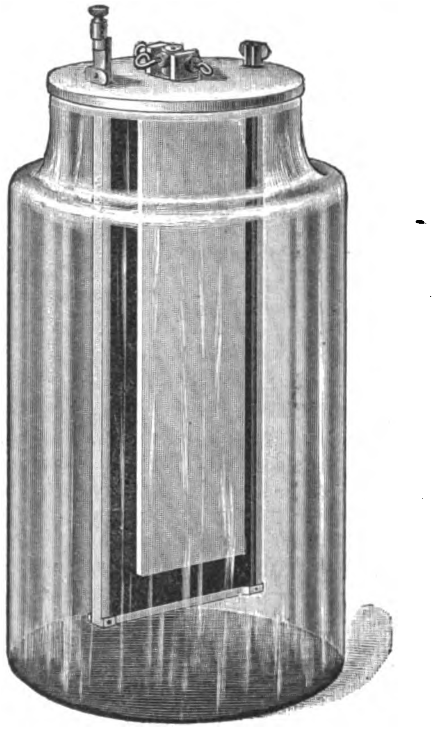


Fig. 3.

The most remarkable properties of this cell are its low internal resistance and its great constancy, which make it equally available for both open and closed circuit work. As an example we may cite the 300 ampere-hour cell which, standing 11¼ inches high by 5⅝ inches in diameter, has an internal resistance of only .05 ohm. The E. M. F. of the cell on continuous hard work is .7 volt, and on light work

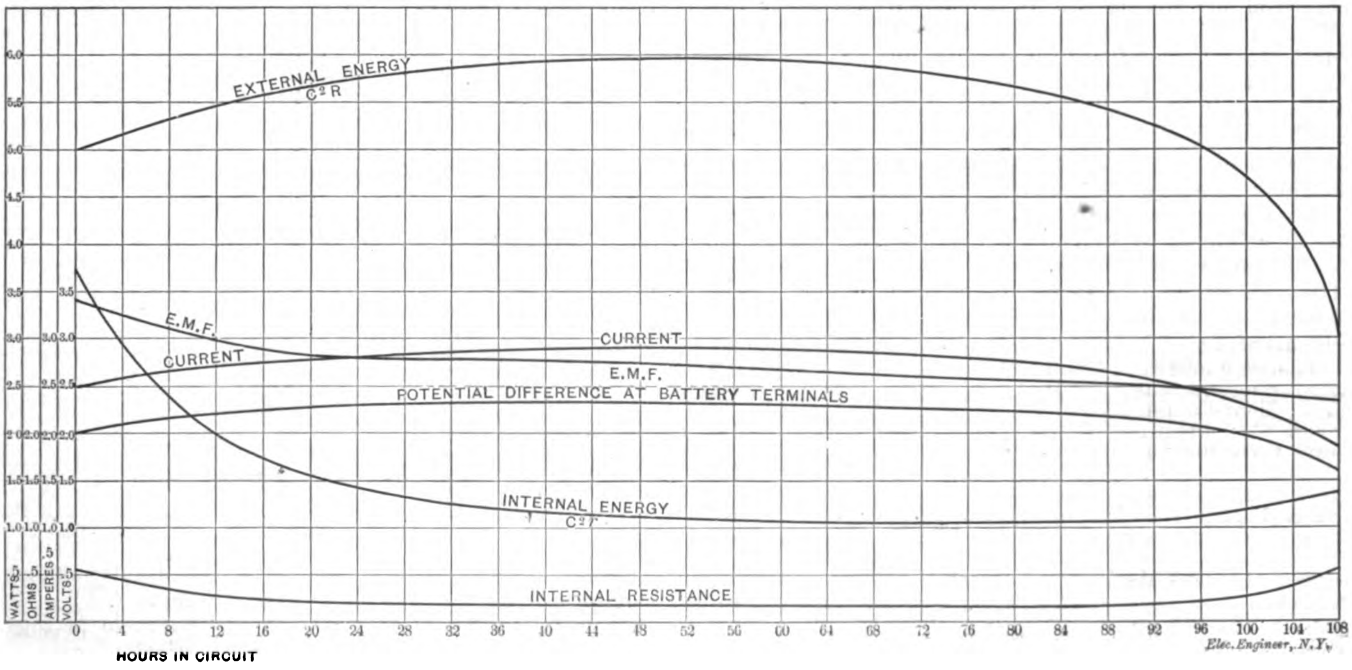


Fig. 2.—Curves Showing Action of Edison-Lalande Battery.

.75 volt. Its initial E. M. F. is .9 volt, but soon falls to the normal, where it remains practically constant during the life of the cell. On short circuit the cell is capable of delivering 14 amperes, while on open circuit there is practically no action on the zinc, and none whatever when the latter is pure.

The action of the cell is admirably shown in the accompanying curves, Fig. 2, which represent the results of very careful tests made at the Edison laboratory upon cells picked out at random from a large number. In this test four of the 300 ampere-hour cells were joined in series and gave the following results :

Weight of zinc before test,	10,017	grammes.
" " after "	8,567	"
Total loss,	1,450	"
Calculated loss from output,	1,444	"
Loss by local action,	6	"
Mean current, - -	2.76	amperes.
Total run, - -	298	ampere-hours.

The loss was calculated as follows, taking the chemical equivalent of zinc as 0.0003367, based on the latest concurring results of Rayleigh and Kohlrausch:

$$2.76 + 108 + 3600 + 0.0008{,}367 = 361; \quad 361 + 4 = 1444.$$

The test, as shown, extended over a period of 108 hours, and both the current and E. M. F. remained practically constant. It will be noted, however, that the external available energy continued to increase for nearly half the period of the test, owing to the almost constant decrease in the internal resistance of the cell, which is also evidenced by the curve representing the internal energy, which falls rapidly from the start. This decrease in internal resistance is due to the fact that the reduction of the oxide to metallic copper at the surface of the negative plate presents an excellent conducting surface, but requires a few hours work in a cell freshly set up. In reading the figures at the left, those referring to the watts, ohms and volts must be divided by four in order to reduce them to the corresponding values for a single cell. During the test the cells were in circuit with a resistance of .8 ohm.

The character of the cell, as outlined above, adapts it to a large variety of work. Thus in telegraphy it can be used as a main line battery, where its low internal resistance permits of operating a large number of lines from it without loss of power, especially in wet weather. For operating locals, also, this quality makes it possible to operate as many as twelve sounders from a single battery consisting of three cells. In an actual test made in the Western Union Telegraph Building in this city three cells furnished current for 15 sounders during 105 working hours. On account of its great constancy, too, the cell is well adapted for small motor work, such as driving sewing machines and other light apparatus; 10 cells of the 300 ampere-hour type being sufficient to operate a sewing machine motor for 40 hours.

For open circuit work the constancy and low resistance of the cell make it well adapted for telephone transmitters, electro-medical apparatus, annunciator work and the like. The cells are manufactured in a number of sizes, ranging from 15 ampere-hours to 900 ampere-hours capacity. The 600 ampere type is shown in Fig 3.

We may add that the manufacture of this cell has been undertaken on a large scale by the Edison Manufacturing Company, special works having been erected for that purpose at Spring Lake, N. J.

THE HUNTINGTON SEARCH LIGHT AND PHOTO-ENGRAVING LAMP.

At the late Maritime Conference held in Washington, attention was drawn to a new form of marine search light embodying several novel features. The Huntington search light, as it is called, is shown in the accompanying engraving, Fig. 1, and consists of a parabolic reflector, containing a series of condensing plano-convex lenses. The lamp employed is of the automatic focussing type and is designed to be run in connection with any constant potential low voltage circuit. The reflector and lamp are enclosed in a waterproof casing and can be turned through any angle in a vertical plane, while the standard upon which the casing is mounted can be turned through any angle in a horizontal plane. As a result, the beam can be directed upon any point between the horizon and the zenith. The employment of the condensing lenses effects a concentration of the beam and prevents its spreading, which usually cannot be avoided even with the most perfect reflectors.

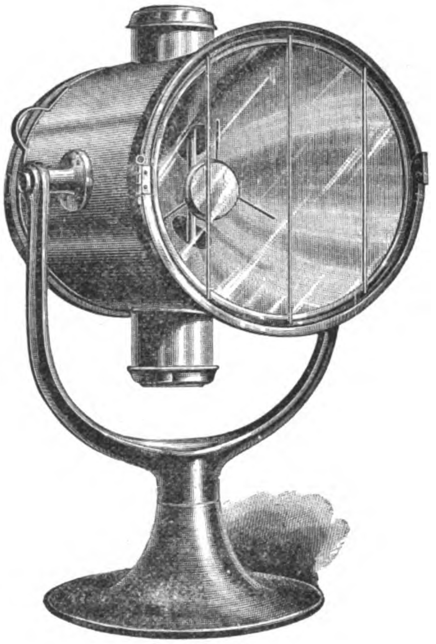


FIG. 1.

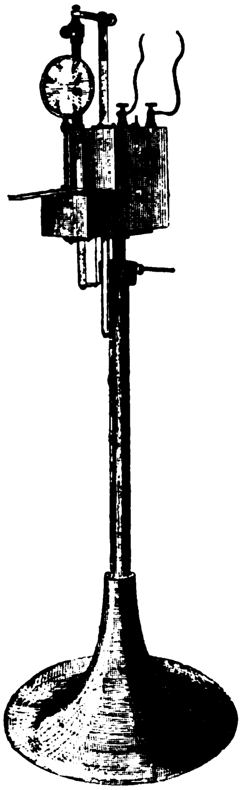


FIG. 2.

These search lights are specially valuable in fogs on board ship, where a beam thrown vertically into the air illuminates the fog and distinctly marks the location of the ship carrying it. This has been proved to be of great value on some of the large steamers plying on the Long Island Sound. Among the other vessels recently equipped with this search light are the steamers "Umatilla," of the Oregon S. S. Company; the "Piedmont," of the Central Pacific Railway Company, running in San Francisco Bay; and another is about to be placed on board one of the Claus Spreckels S. S. Line vessels at San Francisco.

The Scott Electrical Works, of this city, the manufacturers of this apparatus, have also recently brought out an electric arc lamp outfit specially designed for photographic and photo-engraving work. The lamp which is shown in the engraving, Fig. 2, is designed to be run from a constant potential low voltage circuit and is mounted upon an adjustable stand which can be easily transported and moved about. The lens provided enables the operator to enlarge or diminish the area of focused light from a mere focal spot to a circle several feet in diameter, according to the size of the work to be photographed or printed. In this way the wide and general dispersion of light is obviated, and the illumination concentrated exactly upon the point where it is desired. Apparatus of the kind just described is now installed in the workshops of the Star Engraving Company and the New York Electro Light Engraving Company in this city, making the progress of the work in hand independent of sunlight.

THE MICHALES ELECTRIC MINING MACHINE.

The advent of electricity in the mining regions holds forth a promise of the solution of many problems in the transmission of power that have heretofore taxed the ingenuity of miners and engineers. In the coal mining regions especially the great power which can be developed by the compact electric motor without any of the accompaniments entailed by the use of steam has engendered a lively interest in the design of mechanical coal diggers to be operated by electric motors. Among the most recent of these to be brought to the attention of the public is that invented by Captain M. A. Michales, of Pittsburgh, Pa., which he was aided in perfecting by Dr. O. S. Weddell, of McKeesport, Pa.

The machine is illustrated in the accompanying engraving, Fig. 1, which shows the casing in section exposing the working mechanism; Fig. 2 being an end view. The machine when ready for work stands nine feet in length, one and one-half foot in breadth and two and one-third feet high, and weighs about 850 pounds. It is supported on sliding axles for the purpose of balancing the machine when a shorter or longer pick is used, and is provided with a two horse power Tesla motor, from which the power is transmitted through a combination of gear wheels, B, C, E, and shafting, D, to a cam, F, surrounding the drill bar, I. Within this cam on the drill bar there is placed a thumb, *b*, Fig. 2, on the end of which is a small trolley wheel, *a*, which turns and prevents friction as the cam passes in front of it. By the rotation of the cam its inclined surface passes in front of the trolley wheel, forcing it back and up the incline, drawing with it the drill bar, I, against the tension of a powerful spring, K, which encircles it. The backward motion continues until the vertical wall of the cam, F, passes beyond the trolley wheel, when it is automatically released and forced violently forward by the action of the spring, K, the trolley wheel returning to the bottom of the spiral incline.

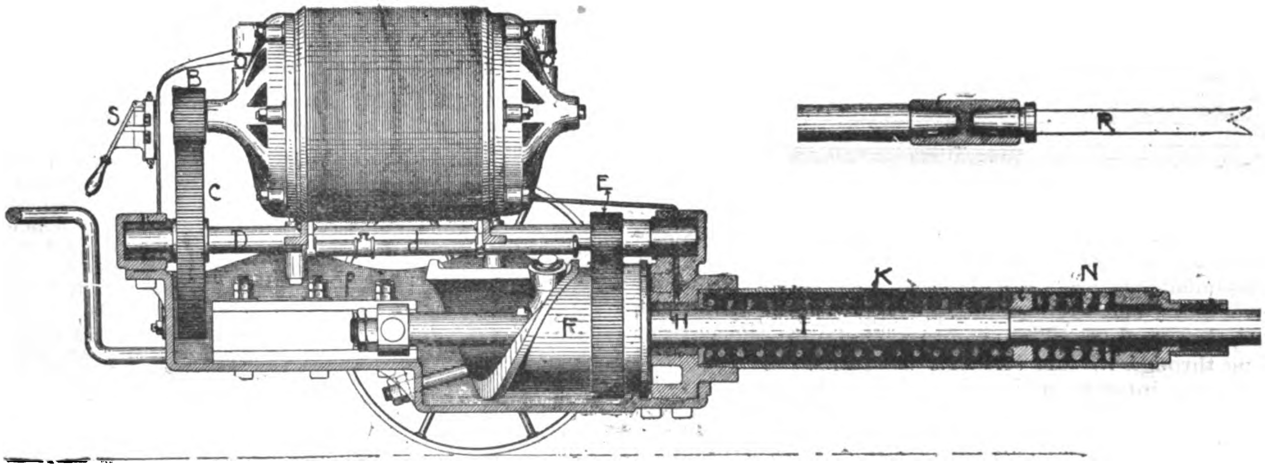


FIG. 1.—THE MICHALES ELECTRIC MINING MACHINE.

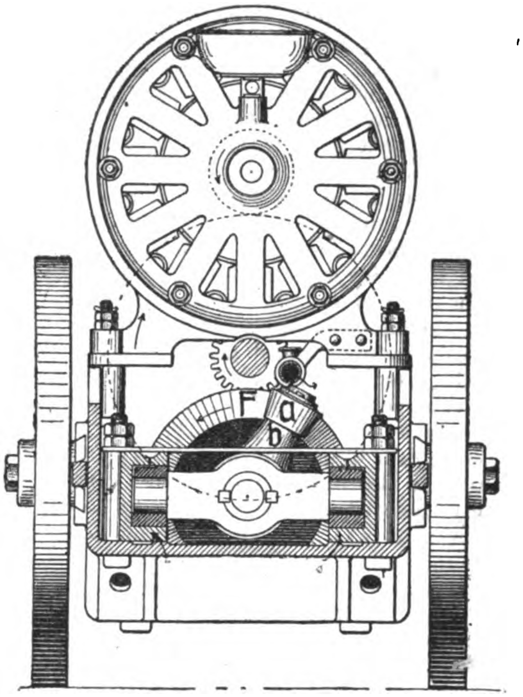


FIG. 2.

In order to relieve the shock to which the machine would be subjected in case the pick should not strike against the coal, there is a very powerful spring, N, interposed between the shoulder, M, on the drill bar and the front end of the tube, L, which surrounds it. The springs, K and N, constructed especially for this machine, are of different tension, and can be changed in a moment, as the character of the work requires.

The machine strikes one hundred and twenty blows per minute, and with a force of 9,000 pounds to the blow.

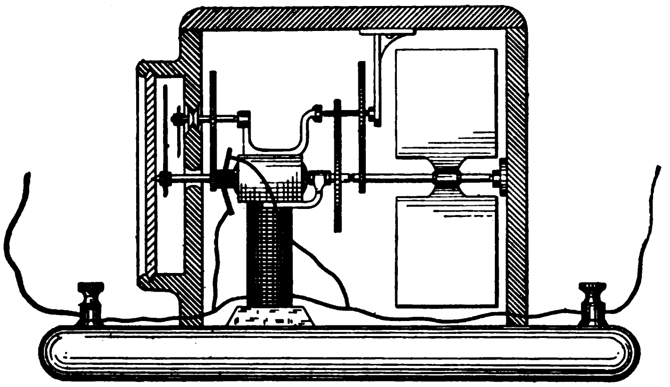
A special feature of the machine is, that at whatever point in the stroke the pick is arrested it is instantly returned from that point ready for the next blow; and when the blow is delivered, even though it be arrested in its course, instead of the machine pushing itself away from the coal as one would naturally suppose it would do, it is said rather to incline toward the coal owing to the momentum of the drill bar.

In working the machine the operator places each blow, as would the hand miner, where it will be most effective, cutting from four to six feet deep. This cut is made on a level with the floor, being of a V-shape, eight inches in front and tapering back to two inches in the rear, making an average cut of five inches. When the under cut is made the operator in like manner can shear the end. One great advantage of this V-shaped cut is that, when the coal falls it will roll over and out of its original position where it can be very advantageously loaded. It requires one man and helper to operate the machine.

To convey the current from the dynamo at the entrance of the mine to the motor on the machine, well insulated wires are strung along the side of the entries near the roof, being fastened to the props or plugs placed in the coal for this purpose. Switches are placed opposite the entrance to each room in order to facilitate the changing of the machine from room to room. Wires are coupled to the main circuit in the entry to convey the current to the machine.

The Tesla motor, manufactured by the Westinghouse Electric Co., has been adopted for operating the machine. This motor is peculiarly fitted for mine service owing to its compactness in design and simplicity of construction. The absence of commutator and brushes allows the armature, which is the only moving part of the motor, to be completely enclosed and protected from mechanical injury. No regulator of any kind is used, and the only piece of apparatus in connection with the motor is a simple switch. The machine, which is built by the Michales Electric Machine Co., of Pittsburgh, Pa., has been thoroughly tested in the hardest coal in Western Pennsylvania, and the results have been of a most gratifying nature.

THE EDISON "MOTOR" METER LITIGATION.



Early Edison Motor Meter.

As recently announced, suit has been brought by the Edison Electric Light Co. against the United States Illuminating Co. of New York, one of the lessees of the Westinghouse Electric Co., of Pittsburgh, Pa., for infringement of one of Mr. Edison's early patents on an electric meter embodying as its principal feature an electric motor, the speed of which is proportional to the current passing through it. As the suit in question has aroused considerable interest in electrical circles on account of its possible effects now that currents are so generally metered, we give below an extract from the patent specification and one of the drawings to which it refers. This patent was issued to Mr. Edison on June 14, 1881, and was preceded only six weeks by the original "weber-meter" which took the form of an electrolytic balance the oscillations of which operated a recording device.

In describing his invention, Mr. Edison uses the following language :—

Generally speaking, it (the meter) consists of a motor, to which is given a certain definite amount of work to do or resistance to motion to be overcome, combined with registering devices which register the amount of work done or resistance to motion overcome.

I have found that the rapidity with which the motor will accomplish its work with a definite loading is proportioned to the amount of current energizing it. Hence, if the motor be arranged to have a slow motion when the amount of current necessary for, say, one translating device passes through the circuit, its speed will be increased proportionately as the number of translating devices using current is increased.

The motor may be placed with its field and armature coils both directly in the main circuit or both in a shunt-circuit. The field-coils may be placed in the direct circuit and the armature in a shunt thereto.

The loading or resistance may be given in a variety of ways. For instance, fan-blades or wings may be connected to the armature-shaft by multiplying gearing ; or, preferably, blades or wings may be driven in a tank or dash-pot filled with a thick liquid—such, for instance, as are used in gas-meters—by slowing down gearing or worm and screw, so that the movement of the registering devices is much less than that of the actuating rotating armature.

We give also the claims which are embodied in the patent, as follows :—

1. The combination with an electric circuit containing translating devices of an electric motor having a definite loading and apparatus for registering the work done, substantially as set forth.
2. The combination of an electric circuit, an electro-motor, a fan driven thereby, and a registering apparatus, substantially as set forth.
3. The combination of an electric circuit, an electro-motor, a fan or blades driven thereby, a vessel or tank in which the fan or blades are placed, and registering apparatus, substantially as set forth.
4. The combination of an electric circuit, an electro-motor, a fan or blades, a vessel or tank filled with liquid, in which the blades or fan are placed, and a registering apparatus, substantially as set forth.
5. An electric meter consisting of a motor having a definite work to perform or loading to overcome, and registering devices, substantially as set forth.

In the complaint filed by the Edison company it is alleged that the well-known Shallenberger meter infringes the above claims.

Besides the form of motor meter described above, Mr. Edison also constructed one in which the principle involved in the operation of "Sturgeon's wheel" was employed. The armature of this meter which is still in existence, consists of a copper cylinder revolving between two pole pieces, and by employing mercury contacts friction is almost entirely avoided. As our readers are aware, however, Mr. Edison's experiments finally led him to adopt the electrolytic meter as the standard in his work and for commercial practice.

DEMONSTRATING ELECTRIC RESONANCE.

Dr. Lodge, in a recent number of *Nature*, describes a simple lecture experiment to demonstrate electric resonance. The oscillator consists of a Leyden jar, whose inner and outer coatings are connected by means of a rather large loop of wire to two knobs placed near together so as to form a spark gap. The resonator consists of a similar jar whose coatings are connected by a loop of about the same dimensions, but the resistance of which may be adjusted by sliding a copper piece along two parallel wires connected up in circuit. An overflow path is provided for the second jar by means of a strip of tinfoil pasted over its lip and almost long enough to connect the two coatings. By adjusting the position of the slider, the second jar responds every time the first discharges. Professor Lodge finds that it is not necessary to use long sparks for these experiments, and that, in fact, the vibrations are steadier and more definite with short ones.

.... W. J. Macquorn Rankine introduced the word "efficiency" to denote the ratio of the useful work done by a machine to the whole work done.

.... Franklin's view that positive charge was excess, and negative charge was a deficit, in a certain standard quantity of electric fluid which all bodies naturally possessed in their neutral state, remains practically true.—*Oliver J. Lodge.*

ELECTRICAL ENGINEERS.

FRANCIS JARVIS PATTEN.

F. **Jarvis Patten**, late lieutenant of the United States Army, the subject of our portrait in this issue, was born at Bowdoinham, Maine, in 1852. He is the eldest son of the late Captain Jarvis Patten, first Commissioner of Navigation of the United States, and is a descendant of one of the oldest families of his native state, his great-grandfather having served there as a commissioned officer in the colonial forces before the Declaration of Independence.

From early youth Lieutenant Patten enjoyed exceptional educational advantages. His father having decided for him a professional career, his preparation for it was urged with such dispatch that when a boy he complained of harder work and a more severe restraint while at home during vacations that when pursuing his regular course of study at school.

He developed at an early age a strong talent for drawing and constructive design, but for fear that he might become an artist all practice in this line was persistently discouraged, and he was put closer than before at Latin and the Classics, for which he displayed no great fondness.

When he was thirteen years of age business arrangements took his parents to Europe, and for the next four years he was kept at school on the Continent for further linguistic training, and returned to his native land at seventeen conversant with the French and German languages, and having also a slight knowledge of Latin, less of Greek and none whatever of the physical sciences. It was now time to choose a college course with a view to a professional career, and Cornell University, then a new institution, was chosen, more because of his deficiency in Greek than for any other reason. This chance selection proved fortunate, for at this institution he followed the scientific course and became an earnest student of subjects more congenial to his tastes. A frolic in the third year of his course severed his connection with this college, and while at home under sentence of suspension for a term he was offered and accepted a cadetship at West Point.

At the Military Academy he stood high in his class in all the scientific branches, and particularly in the engineering course. He was graduated and commissioned a lieutenant in the regular army in 1877, and from that time until 1887 his life was that of an army officer on the western frontier, where he participated in several Indian campaigns and engaged in much of that sort of engineering work incident to army life in the West. During this period he had much time for reading and study, and had never ceased to be a student.

On a visit to the eastern states in 1883 the marked development in all electrical applications which had really been brought to a practical value during his long stay in the West turned his attention to this subject, and he decided that in this direction lay the opportunity to apply the training to which he had given his best efforts. He set about at once to equip himself for this work and to familiarize himself with existing developments, as well as the new theories of this subject upon his return to the army, and devoted his spare time until 1887 to a study of the practical applications of the new science and its underlying principles.

So interested did he become in this work that he soon fell to inventing. His first effort in this direction was a "self-recording electrical target" designed for army use. It received some development and was put to a practical test, but was deemed too expensive and too radical a change for the service and therefore did not prove remunerative. Numerous minor inventions followed as his attention drifted to other applications.

It was, however, while investigating the peculiar properties of electric motors that he perceived the evident application of alternating current motors to synchronous multiplex telegraphy. If he was not the first to conceive this idea he was certainly the first to apply it, and by its use he has developed a system of synchronism that is self-corrective and has proved to be practically perfect, rendering possible an entirely new and original system of telegraphy by which twelve messages can be sent at the same time over the same wire without interference. Lieutenant Patten has brought this system, which involves many original ideas and applications, to a practical form in a remarkably short period of time, and besides this he has found time to produce and develop numerous other inventions of marked originality and novelty. Among these we may mention alternating motors of various forms, and a novel system of distribution by alternating curents, which admits of two applications not heretofore deemed possible, namely, the charging of storage batteries and the maintenance of a constant magnetic field by means of the alternating current which renders possible the construction of motors for such circuits, having all the characteristics of ordinary direct current machines.

Lieutenant Patten was married in 1883, and since his resignation from the army has resided in New York.

.... The more learned a person is, the more he is convinced that he does not know what electricity is.—*Professor John Trowbridge.*

.... The experience in New England has been that every gas company has increased its sales of gas since electric lights have been introduced.—*A. F. Upton.*

.... **Franklin's** view that the electric fluid was never manufactured, but was taken from one body to give to another, so that one gained what the other lost—no more and no less—remains practically true.—*Oliver J. Lodge.*

.... It is of the highest importance in a scientific point of view, as well as from the point of view of progress in material wealth, that the principles and details of science should be spread broadcast.—*Professor W. A. Anthony.*

SOME TESTS ON THE EFFICIENCY OF ALTERNATING CURRENT APPARATUS.[1]

BY DR. LOUIS DUNCAN AND MR. W. F. C. HASSON.

SEVERAL papers have appeared lately on the efficiency of alternating current transformers, some of which have been of a more or less theoretical nature, while others have given the results of actual tests. I have never, however, seen any tests on alternating current dynamos, excepting the experiments made by Dr. Hopkinson and Professor Adams on a de Meritens machine used for lighthouse work. Even the converter tests have given such varying results that one can hardly be certain as to the real efficiency.

The introduction of the alternating system has been so rapid and is so rapidly increasing that people are apparently well enough pleased with the results not to bother about the smaller question of the reasons for them. But whatever the results may be it is of value to know just where the losses in any system may come in, so that we may seek how to avoid them ; if we are succeeding, it may enable us to increase the profits,—if we are losing, it may help us to avoid further loss.

The apparatus, the measurement of which is the main subject of this paper, consisted of a Westinghouse 750-light No. 1 dynamo, with a No. 2 exciter and an outfit of 40-light converters. This apparatus had been presented by the Westinghouse Electric Company to the Johns Hopkins University, and was tested a couple of months ago. The workmanship of the machines is excellent.

The plant consisted of a 75 h. p. Armington & Sims engine driving the dynamo and exciter through a Tatham transmission dynamometer. Engine, dynamometer and dynamos were firmly secured to heavy parallel timbers which served as a foundation. The converters were banked on a wooden framework at a distance of some 30 yards from the dynamo, and their primaries were permanently secured to the dynamo circuit, a switch in the latter serving to cut them off when desired. The ammeter belonging to the plant was put in this circuit and was read when efficiency measurements were being taken. The secondaries of the converters were taken to a switch-board and then to incandescent lamps mounted on racks.

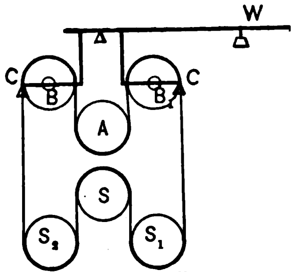


FIG. 1.

Power measurements.—The Armington & Sims engine supplying the power worked regularly and satisfactorily and the governor could be adjusted to give the speed required at the dynamo. The Tatham dynamometer was the one used for power measurements at the International Electrical Exhibition, held in Philadelphia, in 1884, where its accuracy was checked by making with it a determination of the mechanical equivalent of heat. The result obtained in the latter measurement was 772.8 foot pounds per degree Fahr., and shows that the dynamometer is practically accurate. A description of the experiments and of the instrument may be found in the report of the test made to the Franklin Institute, but it will not be out of place to briefly describe the apparatus here.

An endless belt, as shown in Fig. 1, passes over the driven pulley, S, to the shaft of which the engine is belted, round the pulleys, S_2 and B, to the driving pulley A, and back over B_1 and S_1 to S, again. The bearings of the pulleys B and B_1 are in cradles pivoted on knife edges, C, at their outer ends, and at the inner ends are connected by links at equal distances on the two sides of a knife edge which supports the scale beam, W. The outer side of the belt passes through the line of the knife edges, C, and therefore has no effect on the scale beam, but the tensions of the inner parts of the belt act directly on the scale beam, and as they are on opposite sides of the fulcrum they act against one another. The beam is so graduated that this difference of tension is read off directly in pounds, and this quantity—the difference of tension of the belt on the two sides of A—multiplied by its circumference and speed, gives the horse-power delivered. A weight travels on the beam, W, and readings can be taken with great accuracy.

Electrical measurements.—The energy in the secondary circuit was measured by means of a Cardew voltmeter and and a Thomson ampere balance. As it is not the custom to put a number of secondaries in parallel, each converter had its separate lamp circuit.

Before making an efficiency test, the potential difference in the primary was regulated,—there being a Cardew voltmeter in that circuit,—and a separate measurement of the potential difference and current in each secondary circuit was made. When the test was actually in progress the voltmeter and ampere balance were used in one of the circuits and the currents and P. D.'s in the others were calculated from the readings in this circuit together with the previous measurements. Both the voltmeter and ampere balance were accurately calibrated, the former being checked after each test, while the latter had its constant determined with both continuous and alternating currents. The P. D. at the terminals of a non-inductive german-silver resistance in circuit with the balance was observed, when a continuous current was flowing, and also with an alternating current of the same period as that employed in the test. The current in each case was calculated from the resistance and P. D., and the results gave no appreciable difference in the constant for continuous and alternating currents.

The following tables show at once the order in which the tests were carried out and the results :—

HORSE-POWER ABSORBED AT VARYING E. M. F.'S.

	E. M. F.		H. P.
	Dyn'mo	Exciter	
Horse-power for exciter, field not made....	0	0	.34
" " field made	0	110	.75
" " dynamo alone...	0	0	2.73
" " dynamo and exciter.......	0	0	3.04
" " " " "	0	107	3.51
" " " " "	1376	124	12.5
" " " " "	1168	104	10.1
" " " " "	1099	105	9.60
" " " " "	1040	105	9.0
" " primaries of converters on.	1216	105	12.0
" " " " "	1171	104	11.8
" " " " "	1107	104	11.12
" " " " "	1048	104	10.64

TABLE OF EFFICIENCY AT VARYING LOADS.

Approximate load.	Exciter.		Dynamo primary.		Converters.		Horse-power in lamp circuit.	Mechanical horse-power.	Loss, in horse-power.	Efficiency.
	E. M. F.	Current.	E. M. F.	Current.	E. M. F.	Current.				
¼	105	9.4	1107	10.	49.5	153.9	10.21	21.83	11.62	46.8%
½	104	10.5	1107	18.9	49.6	338.4	22.50	34.4	11.90	65.4%
¾	101	11.	1113	28.6	50.0	520.7	34.9	48.0	13.1	72.7%
Full	112	11.5	1123	38.1	50.9	739.8	50.48	64.44	13.96	78.3%

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[1] A paper read before the American Institute of Electrical Engineers, March 18, 1890.

EFFICIENCY OF CONVERTERS.

No. 8. 40-*light Converter.*

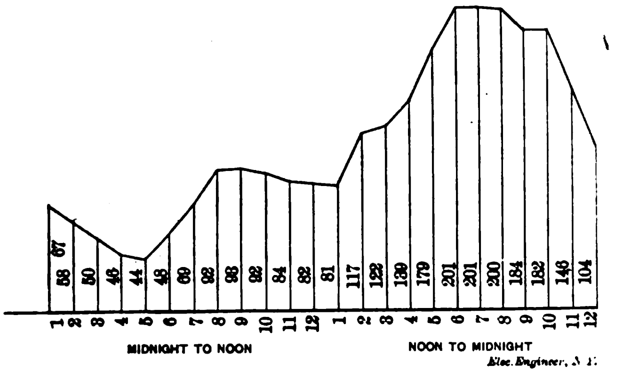
No. of lamps.	Volts.	Watts in secondary.	Loss in watts.	Loss in iron.	Efficiency.
40	50.0	2001	109	....	94.8
0	50.9	0	84	84	....

No. 4. 20-*light Converter.*

No. of lamps.	Volts.	Watts in secondary.	Loss in watts in secondary.	Loss in iron, watts.	Efficiency.
20	48.8	952	106.	95.2	90.0%
15	52.2	817	114.8	108 9	87.6%
10	50.8	506	101.7	99.2	83.8%
5	51.44	264	109.4	108.7	70.7%
0	52.3	0	110.5	110.5	0. %

The efficiency of the converters was measured by placing them in a metal calorimeter, between the double walls of which water was allowed to flow. The temperatures of exit and entrance were observed, as well as the weight of water which passed through; at the same time the current and P. D. in the secondary circuit of the converter were measured. A separate observation gave the radiation, which was of course allowed for, although it was made as small as possible. A number of converters were experimented on but I give but two of them; a 40-lighter, such as was used in the tests, and a 20-light converter which was very carefully tested by two of my students, Messrs. Bliss and McKeen. In the latter case the observations were made at slightly different P. D.'s, and the results show that the loss in the iron varies as we would expect it to vary, that is, very nearly as the square of the voltage. The variation will not be exact, as the losses due to the reversal of magnetism do not vary quite as fast as the square of the induction.

I would like here to call attention to the fact that in an excellent paper read before this Institute, Professor Ryan, of Cornell, found that the losses in the iron of a 10-light converter decreased greatly as the load increased. This was accounted for by the fact that there was a jar (evidenced by the singing of the converter) at the higher loads, due to the attractions of the secondary and primary coils. While it is true that the losses in the cores of very small converters are not exactly constant, yet they are nearly so, and a large part of the decrease found by Professor Ryan is due to the voltage being greater at the low than at the high loads.



Elec. Engineer, N. Y.

FIG. 2.

Looking now at the figures given in the tables we are struck by two things; the very large amount of power absorbed in the core of the armature, and the very small loss in the converters on open circuit. The dynamo losses due to reversals of magnetism and eddy currents, at the E. M. F. used in the test are no less than 6 h. p., while the energy due to reversal of magnetism and eddy currents in the 16 converters is only 1.6 h. p. Another rather striking thing is the almost constant ratio of primary and secondary currents over a considerable range. The maximum efficiency is about 78 per cent. It would seem that the losses could be divided into a constant part, and one varying with the current, but this is not true with the older style and smaller converters of the Westinghouse company.

Suppose we have a plant such as is described above, and use it for commercial lighting. Taking data from one of the local companies employed in supplying incandescent lights on this system we have, for two 2,500 light dynamos, the following outfit of converters :—

Size of Converters.	Capacity.			Number in use.	Total Lamps.
No. 1.	5	16 c. p.	lamps.	44	220
No. 2.	10	"	"	61	610
No. 4.	20	"	"	43	860
No. 6.	30	"	"	49	1,470
No. 8.	40	"	"	64	2,560
Total lamp capacity					5,720
Number of lamps supplied					4,557

I understand that the converters being added are of the larger sizes.

The efficiency of the 30-light converters does not differ greatly from that of the 40-lighters. The accompanying Fig. 2, is a load diagram of this plant, selected from a number of diagrams as giving a fair average curve. If we have our dynamo working to its full capacity then from the above data we would have a converter capacity of twenty-three 40-light converters.

If, as in our test plant, these converters are 40-lighters, or 30-lighters—for the efficiency of these two sizes is about the same,—we would have a mean loss in our plant of, say, 10 h. p. in our dynamos ($9.6 + C^2 R$), and in the converters about 3 h. p. ($2.3 + C^2 R$); or all together about 13 h. p. From the above table we will have 750 lamps supplied, and taking the data from the load curve the average load would be in the neighborhood of 1,300. This corresponds to about 20 h. p., and the efficiency of the plant for 24 hours would be $\frac{20}{33} = 61$ per cent., minus the percentage of loss on the lines. This, in a properly installed system, should not average two per cent., so that the final efficiency would be 59 per cent.

A continuous current dynamo supplying the same outfit of lamps, with a maximum loss in the mains of, say, 15 per cent., would have a greater average efficiency. But I wish to point out that the maximum efficiency of the two plants would be about the same, so that they would require the same capacity of station outfit, boilers, engines, dynamos, etc. When more than one dynamo is provided the efficiency is increased by using only one of them during the times of minimum supply, and always working as far as possible only a little below the maximum capacity of the machines.

Let us consider these results in view of the present condition of incandescent light distribution in the United States. I take it that what may be called domestic electric lighting is largely a matter of the future—it is certainly not a matter of the present. The majority—the great majority—of the lights in use are in shops, saloons, theatres, offices, etc. Most of the lights wired are in use at one time or another during the 24 hours, and the proportion of energy supplied to the total capacity of the lamps connected is much greater than it would be in the case of house lighting, where, on the average, only a small fraction of the possible lamp-hours are actually in use. Under these circumstances the scheme of alternate current distribution is very different from what it will be when the attempt is made to supply an entire city with light, as they are attempting to supply London at the present time.

If the object of the lighting company is to supply the demand that exists at present, then a system employing a number of small converters is preferable. Such a system is flexible and can be installed with a minimum expense for the more or less scattered demand which is presented in even the most closely settled town. I take it that this is the great difference between the alternating and direct systems as at present installed in this country. The former skims over an extended district, taking advantage of its great flexibility to absorb any business which can be got; while the latter settles itself in a densely built centre, installs a larger plant than is primarily demanded, and works up a business within the limits of economical distribution. Therefore, it is hardly right to compare the present systems of direct and alternating supply, as the latter has not been reduced to a point where entire districts are to be supplied.

To show the disadvantage of the present system for domestic supply, suppose we have an ordinary house such as one of us would live in; it would be necessary to have a converter of at least 20-light capacity. The constant loss is, say, 100 watts; so, leaving out the $C^2 R$ loss, we would have a total loss in 24 hours, of $\frac{2400}{750}$, or about 3 h. p. hours, corresponding to, say, 45 lamp hours. Taking my own experience the actual number of lamp hours used is about 30 lamp hours during 24 hours, so the efficiency of the converter would be something like $\frac{30}{75} = 40$ per cent. It is evident that unless the losses in converters can be greatly decreased, a house-to-house distribution with a converter in each house would hardly pay.

It would seem, then, that if gas is to be really displaced and serious competition with it is to be attempted a different system of distribution must be worked out. We must replace the numerous small converters with one large converter supplying a comparatively extended district, thus decreasing the converter capacity, since the law of average can be taken advantage of, and greatly increasing the efficiency. If an extended secondary network is employed, some of the converters may be disconnected from the mains at the turn of minimum demand.

Let us inquire for a moment how the increase in the capacity of converters will modify the designs with which we are familiar. In the first place, if we increase the linear dimensions of any type, since the radiating surface only increases as the square while the volume increases as the cube of the dimension, then we cannot suffer the same loss per cubic centimeter of the iron for the large as for the small sizes. We must decrease the intensity of magnetization or we must decrease the periodicity.

Let us take a typical case. Suppose we have a transformer and double all of its dimensions. If we employ the same induction we will need but one quarter the number of turns in the coils, and as the cross-section of the space occupied by the wire is four times as great, the area of the wire may be sixteen times as much. As the length is twice as great, the resistance in this case is one-eighth. But the losses in the iron are, roughly, eight times as great; this we cannot allow, since the radiating surface is but four times as great; hence we must diminish the induction. In fact we must so arrange things that the loss in the larger converter is only four times that in the smaller, in order to work at the same temperature. As at the low induction used the loss due to hysteresis varies nearly as the square of the induction we may take it roughly that the large converter should have an induction of three-quarters of the smaller one. This will modify our figures. Instead of one-quarter the number of turns we will have one-third, and the resistance of the coils will be one-sixth instead of one-eighth, as we can allow four times the loss that we suffered before, we can have, roughly, five times the output.

As a total result we have five times the output with four times the loss, or, as the $C^2 R$ effect is not important as compared with the other losses, we can have six times the output with the same fall of potential in the secondary. That is, the efficiency of the larger converters will be greater than the smaller ones of the same design and working at the same temperature, but the output per pound of metal will be less.

Suppose when we increase the size we decrease the number of reversals. Take a case, for instance, in which the dimensions are doubled while the reversals are halved, the maximum induction remaining the same. We could have half the turns in the coils, and as they occupy four times the space and are twice as long the total resistance would be one-quarter, and for the same heating effect we would have four times the output.

If we take losses by eddy currents into account there will be a constant per cubic centimeter, provided the period and maximum induction are constant and the thickness of the plates is unchanged; otherwise they will vary as the square of the induction, with a constant frequency, or inversely as the square of the period with a constant maximum induction. This in practice would make the values of the output for the larger currents given above somewhat greater. What I wish to show, however, is that we are limited by heating considerations and considerations of fall of potential in our secondary in the output of large converters. If we consider the properties of the materials of which converters are made we would, I think, find it most economical to make converters that reach the temperature limit, except for the very smallest sizes.

Many of us have, I suppose, read Mr. James Swinburne's paper read before the British Association at Newcastle last year on the "Design of Converters," and have been struck by the fact that almost all of the converter dimensions given by him are impracticable, either on account of the disproportionate heating of the larger sizes, or the excessive fall of potential in the secondary. In increasing the size of dynamos we usually increase the output per pound weight, but there is the vital distinction between dynamos and converters that losses occur through the entire mass of the latter, and as we increase the volume we increase the losses in the same proportion. In the dynamo, on the contrary, there are practically no losses in the heaviest part of the apparatus, *i. e.*, the field magnets. As a result, while we gain in efficiency in the larger sizes, yet we must decrease either our induction or the rate of reversal, and the output per pound is not increased.

POINTERS.

.... I NEVER learned anything, not even standing on my head, but I found a use for it.—*Fleeming Jenkin.*

.... IN selling light you are selling power; that is the one thing always to be kept in mind.—*A. F. Upton.*

.... LINES of force have no more and no less existence than rays of light; both are convenient modes of expression.—*Oliver J. Lodge.*

.... EVERY new thing involving the application of scientific principles or truths, is a distinct advance in science itself.—*Professor W. A. Anthony.*

... HARDLY a problem suggests itself to the fertile mind of the inventor or investigator without suggesting or demanding the application of electricity to its solution.—*Professor Albert A. Michelson.*

.... WE shall never know what electricity is any more than we shall know what energy is. What we shall probably be able to discover is, the relation between electricity, magnetism, light, heat, gravitation, and the attracting force which manifests itself in chemical changes.—*Professor John Trowbridge.*

.... THE principles of each science are few, positive, permanent, and such as can be learned from lectures and books. The applications are innumerable; their results cannot be made the subject of absolute calculation. The methods vary from year to year and from month to month; they can neither be learned nor taught in the lecture room.—*Fleeming Jenkin.*

.... THE world has learned to value science for her beneficence, her fruitfulness and her helpfulness. It has learned that to a true union of science with art only, are we to look for the methods and the means by which mankind is to be finally, if at all, emancipated from the yoke of overburdening labor now so terribly oppressing the race.—*Professor Robert H. Thurston.*

DATA AND PLOTS OF VARIOUS INCANDESCENT LAMPS TOGETHER WITH AN IMPROVED METHOD OF TESTING.

II.

BY WM. L. PUFFER.

From Graduation Thesis on the Distribution of Light Around Incandescent Lamps, with Efficiency Measurements. By Henry M. Hobart and Earl W. Gannett, Massachusetts Institute of Technology.[1]

The object of this investigation was to determine the efficiencies of various makes of incandescent lamps. The method used was similar to, but in all respects an improvement upon, that used in 1885, by the Franklin Institute. The component measurements to be made are these :—

1. The current passing through the lamp.
2. The difference of potential between the lamp terminals.
3. The required photometer readings.

The current was determined by a Thomson current galvanometer placed in series with the lamp and an adjustable resistance for regulating the potential. The difference of potential was determined by a Thomson potential galvanometer of 7,500 ohms resistance connected to the terminals of the lamp. Great constancy of potential was rendered possible by the use of an automatic governor designed and built by the department. The current readings were corrected by deducting the current flowing through the potential galvanometer.

(The description of holder and method of working are omitted as they are similar to those given in first part of the paper.—W. L. P.)

The following varieties of lamps were tested in the order given :—

Lamps C, D, M,	Sawyer-Man,	110 volts,	16 c. p.,	marked 16 c. p.,	A 3-16 c. p.,	A 4
" A, B, L,	"	60 "	16 "	" 16 "	B 4	
" I, J, K,	Weston,	110 "	16 "	" 16 "	110 volts, B.B.G.	
" E, F, N,	Edison,	110 "	16 "	"	Edison's patents, 16 c., 3.1	
" R, S, T,	"	93 "	16 "	"	" " 16 c.	
" O, P, Q,	"	85 "	16 "	"	" " 16 c.	
" G, H,	"	110 "	32 "	"	" " 32 c., 3.1	

Three separate lamps of each kind were tested ; two separate tests by different observers were made on each lamp and their means taken to represent the values for that particular type of lamp.

Therefore, 42 tests were made on 21 lamps of seven varieties. Every final result is the mean of the results for three separate lamps and for six separate tests. Every point plotted on the diagrams is the mean of 24 settings of the photometer disc. Four careful determinations of the value of "H" were made by the Kew magnetometer, at the outset. The four results and their mean are .1747 — .1751 — .1744 — .1748. Mean = .1748.

The accuracy of the results was ensured by checking at three different stages of the work, the means of the results and the results of the means.

Photometric observations on lamp J, being a mean of observations J, by E. W. G. and J_1, by H. M. H.

Angle.	Hor. 0°.	Vert. 0°.	Vert. 45°.	Vert. 90°.	Vert. 135°.
0	14.90	15.13	24.28	25.68	20.46
30	20.13	15.13	22.63	24.25	18.45
60	25.70	11.93	15.41	17.73	13.33
90	27.73	8.58	8.85	9.18	9.00
120	23.23	11 25	15.60	18.18	13.81
150	17.58	13.60	21.53	25.15	18.88
180	14.91	15.38	24.45	27.10	20.40
210	20.03	15.13	21.83	23.73	18.13
240	25.60	11.46	14.78	14.13	10.53
270	27.83	0	0	0	0
300	23.86	9.03	12.08	12.46	12.50
330	17.53	14.28	21.03	22.71	18.03
0	15.13	15.18	24.23	25.88	20.55

EDISON 110 VOLT, 16 c. p., 3.1 WATTS.

Mean results of lamps, E, F, N, and the mean of these three means.

	E.	F.	N.	Mean.
Mean standard reading..	16.07	13.08	14.57	14.57
Mean sph. candle-power.	12.49	11.49	13.03	12.34
Spher. reduction factor..	0.779	0.879	0.895	0.851
Mean hor. candle-power.	16.16	15.33	16.80	16.10
Hor. reduction factor...	1.007	1.172	1.152	1.111
Ratio of sph. c. p. to hor. c. p	0.774	0.751	0.776	0.767
Volts....................	110.0	110.0	110.0	110.0
Amperes	0.4705	0.4377	0.4574	0.4552
Watts....................	51.76	48.15	50.31	50.07
Watts per sph. c. p......	4.156	4.191	3.862	4.070
Watts per hor. c. p......	3.216	3.147	2.996	3.120
Resistance (hot)	233.8	251.3	240.5	241.9

The accompanying two tables are taken from the thesis to show methods of combining results and the agreements.

In addition to these results it is necessary to know three more things before deciding which lamp is the best one and the cheapest to use :—1, cost of new lamps ; 2, life of lamp when burned at proper voltage ; 3, fall of candle-power due to increase in the life of lamp.

Under the cost of lamps must be reckoned the percentage of broken lamps which are always found in a batch of new lamps, the number which break instantly or within a

RESULTS OF OBSERVATIONS OF MESSRS. GANNETT AND HOBART, '89. TABULATED AND ENLARGED (W. L. P.)

Lamp—1888-'89.	Mean standard reading.	Mean spherical candle-power.	Spherical reduction factor.	Mean horizontal candle power.	Horizontal reduction factor.	Sph. ÷ Hor.	Volts.	Amperes.	Watts.	Watts per sph. candle-power.	Watts per hor. candle-power.	Lamps per e. h. p.	Mean sph. candles per e. h. p.	Mean hor. candles per e. h. p.
Edison. 85 volt, 16 c. p.	12.06	10.48	0.873	13.30	1.108	0.789	85.00	0.6200	52.70	5.04	3.98	14.14	148.	188.
Edison. 93 volt, 16 c. p.	13.38	12.65	0.947	15.83	1.185	0.800	93.00	0.7240	67.33	5.32	4.26	11.07	140.	175.
Edison. 110 volt, 16 c. p.	14.57	12.34	0.851	16.10	1.111	0.767	110.0	0.4552	50.07	4.07	3.12	14.90	184.	240.
Edison. 110 volt, 32 c. p.	27.21	24.08	0.890	30.39	1.122	0.793	110.0	0.8507	93.58	3.89	3.08	7.97	192.	242.
Weston. 110 volt, 16 c. p.	16.50	20.92	1.347	24.81	1.592	0.845	110.0	0.6451	70.97	3.47	2.93	10.51	220.	261.
Sawyer-Man. 60 volt, 16 c. p.	23.54	19.06	0.810	23.39	0.994	0.815	60.00	0.9521	57.12	3.00	2.45	13.06	249.	306.
Sawyer-Man. 110 volt, 16 c. p.	28.17	23.57	0.835	28.58	1.010	0.826	110.0	0.6724	73.97	3.17	2.62	10.09	239.	288.

---

[1] These results and plots are taken directly from the thesis with no correction or re-calculations, which seemed unnecessary. I have added a few tables and words which are in all cases accompanied by my initials. The work was intended for, and is, an extension of previous work, under far better conditions and with the latest lamps obtainable.—WM. L. PUFFER.

1889 *lamps in order of efficiencies expressed in terms of watts per spherical candle-power.* (*W. L. P.*)

Maker.	Voltage.	Rated c. p.	Watts per c. p.	Candles per e. h. p.
1. Sawyer-Man....	60.	16.	3.00	249.
2. "	110.	16.	3.17	239.
3. Weston...................	110.	16.	3.47	220.
4. Edison....................	110.	32.	3.89	192.
5. "	110.	16.	4.07	184.
6. "	85.	16.	5.04	148.
7. "	93.	16.	5.32	140.

1889 *lamps in order of efficiencies expressed in terms of watts per horizontal candle-power.* (*W. L. P.*)

Maker.	Voltage.	Rated c. p	Watts per c. p.	Candles per e. h. p.
1. Sawyer-Man...............	60.	16.	2.45	306.
2. "	110.	16.	2.62	288.
3. Weston............	110.	16.	2.93	261.
4. Edison....................	110.	32.	3.08	242.
5. "	110.	16.	3.12	240.
6. "	85.	16.	3.98	188.
7. "	93.	16.	4.26	175.

1889 *lamps. Showing candle-power actually given out in spherical candle-power in percentage of rated candle-power.* (*W. L. P.*)

Maker.	Voltage.	Rated c. p.	Percent.
1. Sawyer-Man...............	110.	16.	147.
2. Weston....................	110.	16.	131.
3. Sawyer-Man...............	60.	16.	119.
4. Edison	93.	16.	79.1
5. "	110.	16.	77.1
6. "	110.	32.	75.2
7. "	85.	16.	65.5

1889 *lamps. Showing candle-power actually given out on the horizontal circle in percentage of the rated candle-power.* (*W. L. P.*)

Maker.	Voltage.	Rated c. p.	Per cent.
1. Sawyer-Man...............	110.	16.	178.
2. Weston.....................	110.	16.	155.
3. Sawyer-Man........	60.	16.	146.
4. Edison	110.	16.	101.
5. "	93.	16.	98.9
6. "	110.	32.	95.0
7. "	85.	16.	83.1

Comparison of last four tables, showing position of lamp when compared according to these methods. (*W. L. P.*)

Maker.	Voltage.	Rated c. p.	Watts per sph. c. p.	Watts per hor. c. p.	% sph. c. p.	% hor. c. p.
Sawyer-Man.......	60.	16.	1	1	3	3
"	110.	16.	2	2	1	1
Weston............	110.	16.	3	3	2	2
Edison............	110.	32.	4	4	6	6
"	110.	16.	5	5	5	4
"	85.	16.	6	6	7	7
"	93.	16.	7	7	4	5

few minutes of the time the current is first turned on; those with defective fittings or otherwise in such condition that they cannot be burned. What experience I have had with lamps of the above kinds points to the conclusion that from three to five per cent. is about the proportion of loss; from actual count on one of the makes I find that I lose about five per cent. of every new lot. This loss makes a very material difference in the cost of a lamp and must be taken into account. As to the life of lamp and fall of candle-power with age, I have no figures ready for publication. It is a very open question whether a lamp's life ends when it ceases to give say 50 per cent. of its original light or when it becomes blackened, or when the filament actually breaks. From the moment the current is first turned on the lamp begins to depreciate, sometimes increasing and sometimes diminishing in candle-power, or even both, until the filament finally breaks. I believe in a lamp that maintains its original light, or possibly increases it, until it has run a number of hours and then fails rapidly and breaks, and not in a lamp which is at rated candle-power only for the first few hours of its life and then dies by slow consumption at the end of its guaranteed life with a light only perhaps five or ten per cent. of its original brightness, having lived as a "red-hot hair-pin" for the last half of its life.

It should be stated that all of the Weston and Sawyer-Man lamps were bought in Boston of the supply companies out of stock, and were in their original wrappers when taken for test. No questions were asked as to the use to which the lamps were to be put. Of the Edison lamps tested, the 110 volt 16 c. p. lamps came out of a stock of lamps on hand for general lighting use, but the rest were ordered by the local Edison company from the lamp factory, knowing that they were for testing purposes. Lamps could not be bought without a declaration of the purpose for which they were wanted.

ROGERS LABORATORY OF PHYSICS,
Mass. Inst. of Technology, Dec., 1889.

DR. LOUIS BELL ON LONG-DISTANCE ELECTRIC TRACTION.

At the meeting of the Chicago Club, March 17th, a paper written by Dr. Louis Bell on "Electric Motors for General Railroad Work" was read and discussed. Like Lieutenant F. J. Sprague, the author of the paper, looks confidently for the operation of electrical trains at railroad speed. He thought that it was practical to build motors sufficiently large and reliable to equip trains to run on through lines. The problem of transmitting power could be solved by dividing the road into sections, by locating a power station in the centre of each division. At the present time he did not think such a plan would be much more economical than the method of using locomotives unless a saving could be effected by better firing and by using a cheaper grade of coal, and by operating motors lighter than the engines now employed in drawing trains. It would be possible to make the motor lighter, he thought, because the electric current transmitted to the rails gave an increased traction. In the case of suburban roads and of short lines between neighboring cities, he thought the substitution of electric motors for locomotives would result in a substantial reduction of expenditure. The electric motor, he thought, was especially adapted for use on elevated railways, and he could see no reason for the continued employment of engines for drawing trains when the electric system on such a road was so incomparably superior.

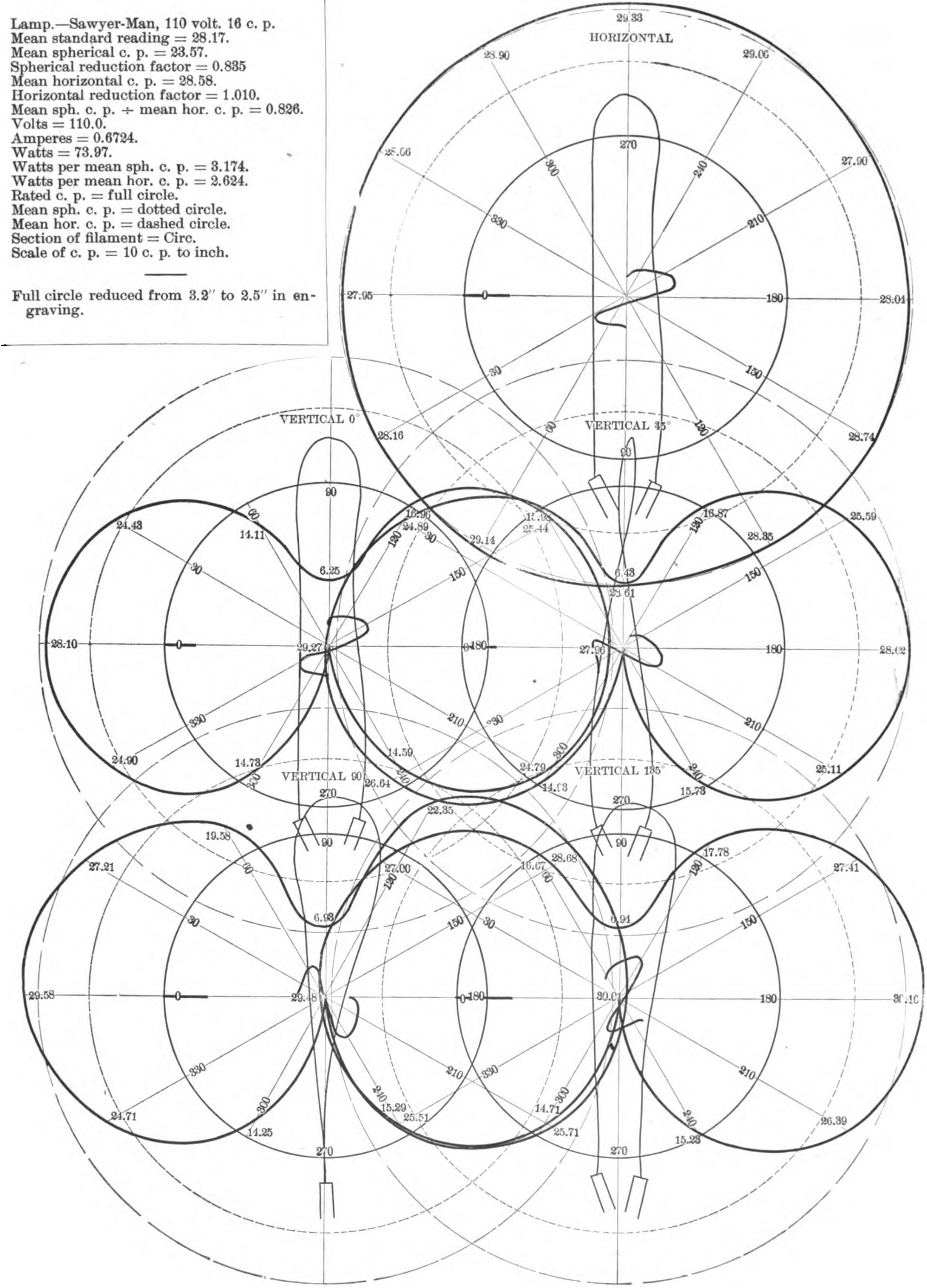
.... THE existence of an ether can legitimately be denied in the same terms as the existence of matter can be denied, but only so.—*Oliver J. Lodge.*

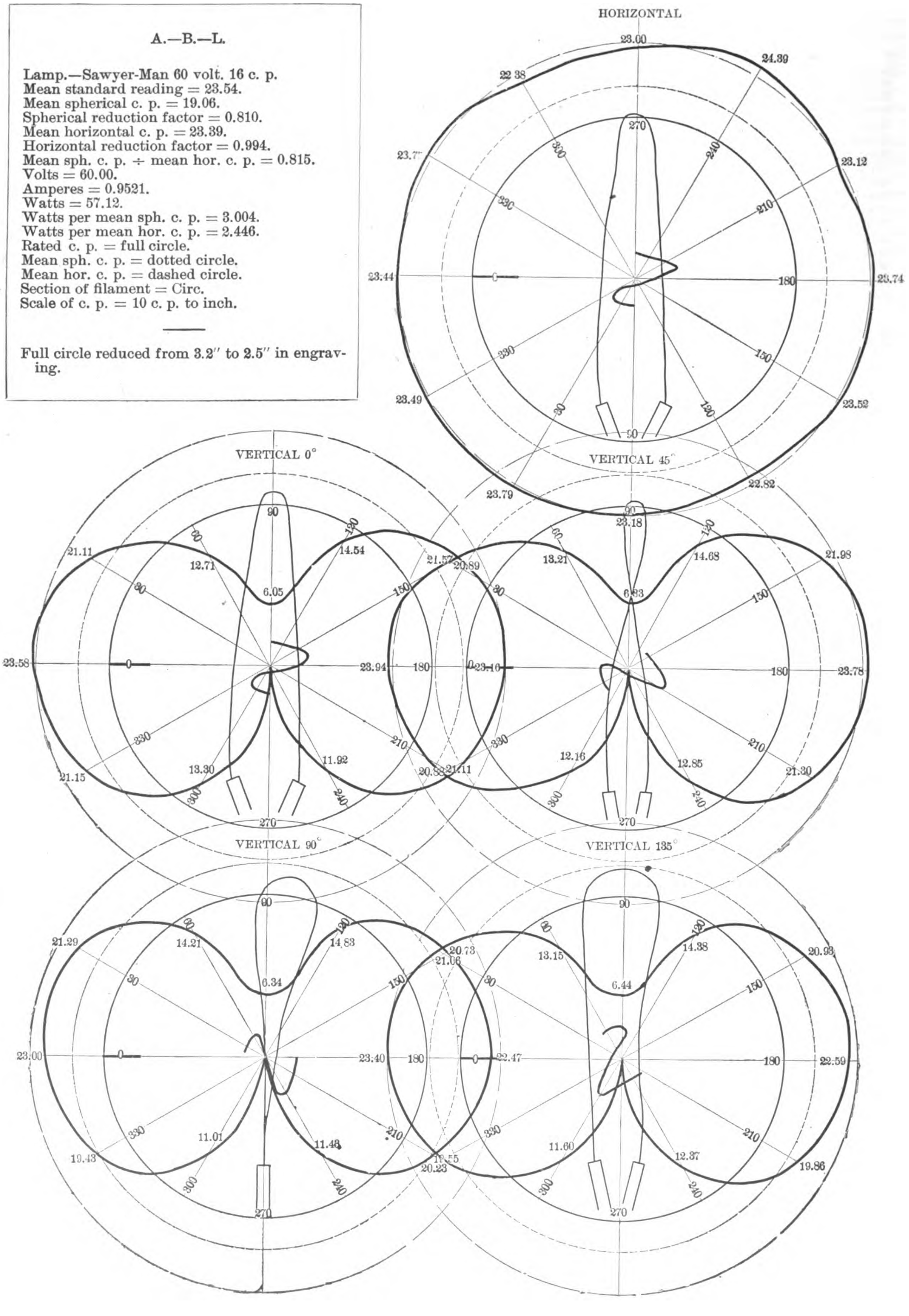
.... IF one electric light company purchases its fuel for 50 cents per ton and another pays $3, the results will soon show in the profits.—*A. F. Upton.*

C.—D.—M.

Lamp.—Sawyer-Man, 110 volt. 16 c. p.
Mean standard reading = 28.17.
Mean spherical c. p. = 23.57.
Spherical reduction factor = 0.835
Mean horizontal c. p. = 28.58.
Horizontal reduction factor = 1.010.
Mean sph. c. p. ÷ mean hor. c. p. = 0.826.
Volts = 110.0.
Amperes = 0.6724.
Watts = 73.97.
Watts per mean sph. c. p. = 3.174.
Watts per mean hor. c. p. = 2.624.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = Circ.
Scale of c. p. = 10 c. p. to inch.

Full circle reduced from 3.2″ to 2.5″ in engraving.





A.—B.—L.

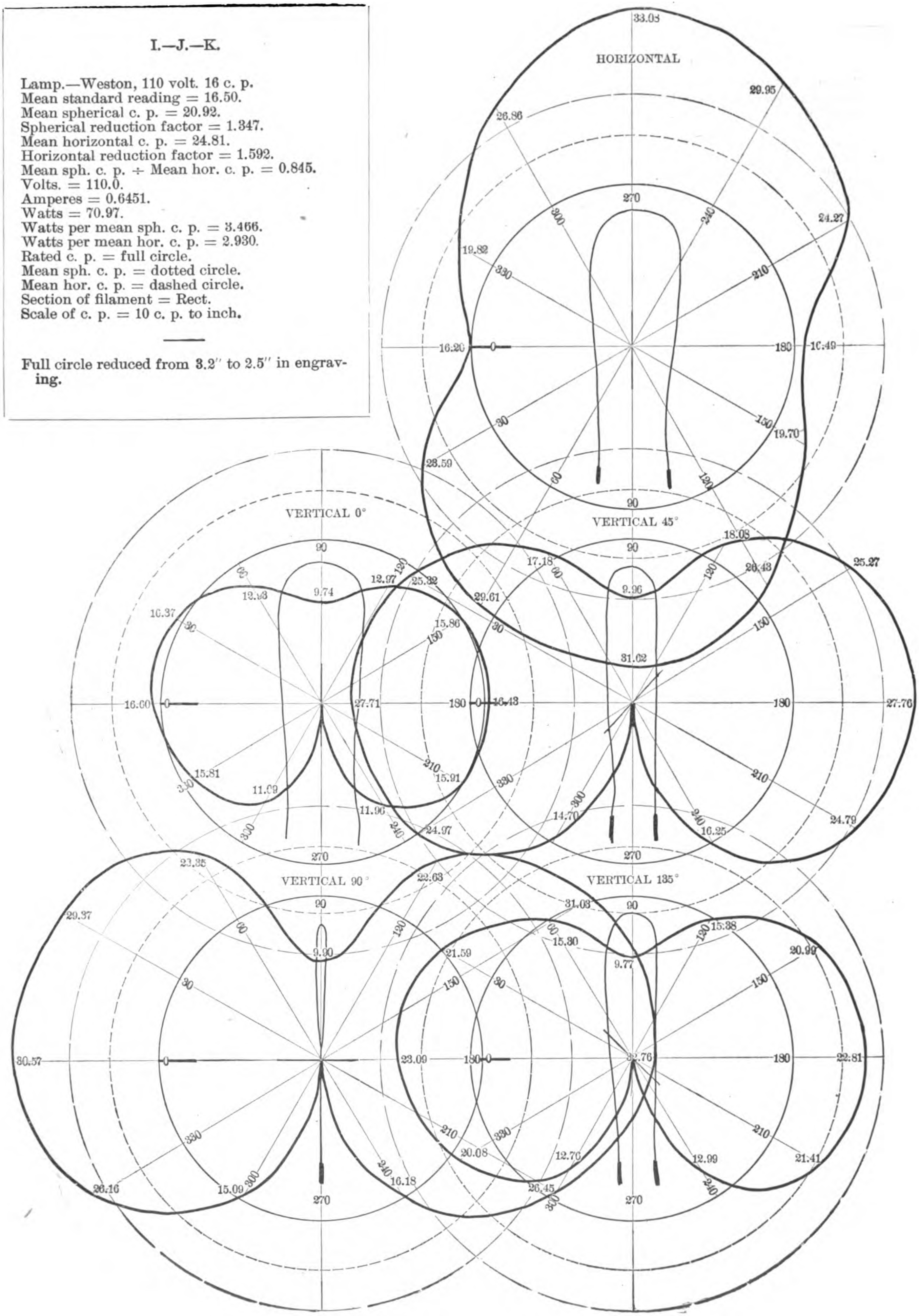
Lamp.—Sawyer-Man 60 volt. 16 c. p.
Mean standard reading = 23.54.
Mean spherical c. p. = 19.06.
Spherical reduction factor = 0.810.
Mean horizontal c. p. = 23.39.
Horizontal reduction factor = 0.994.
Mean sph. c. p. ÷ mean hor. c. p. = 0.815.
Volts = 60.00.
Amperes = 0.9521.
Watts = 57.12.
Watts per mean sph. c. p. = 3.004.
Watts per mean hor. c. p. = 2.446.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = Circ.
Scale of c. p. = 10 c. p. to inch.

Full circle reduced from 3.2″ to 2.5″ in engraving.

I.—J.—K.

Lamp.—Weston, 110 volt. 16 c. p.
Mean standard reading = 16.50.
Mean spherical c. p. = 20.92.
Spherical reduction factor = 1.347.
Mean horizontal c. p. = 24.81.
Horizontal reduction factor = 1.592.
Mean sph. c. p. ÷ Mean hor. c. p. = 0.845.
Volts. = 110.0.
Amperes = 0.6451.
Watts = 70.97.
Watts per mean sph. c. p. = 3.466.
Watts per mean hor. c. p. = 2.930.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = Rect.
Scale of c. p. = 10 c. p. to inch.

Full circle reduced from 3.2″ to 2.5″ in engraving.

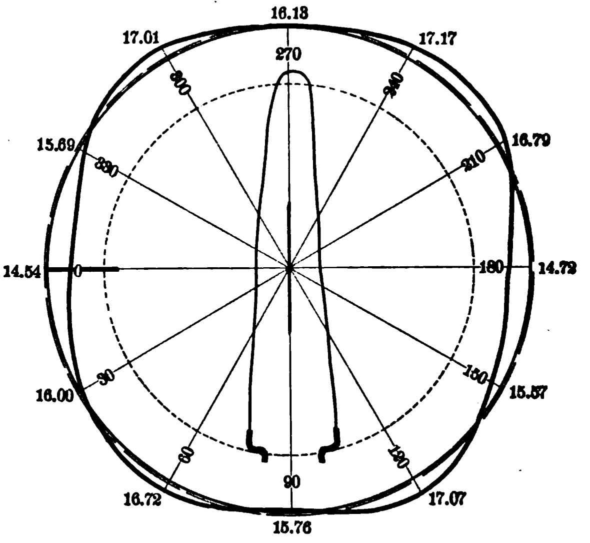


E.—F.—N.

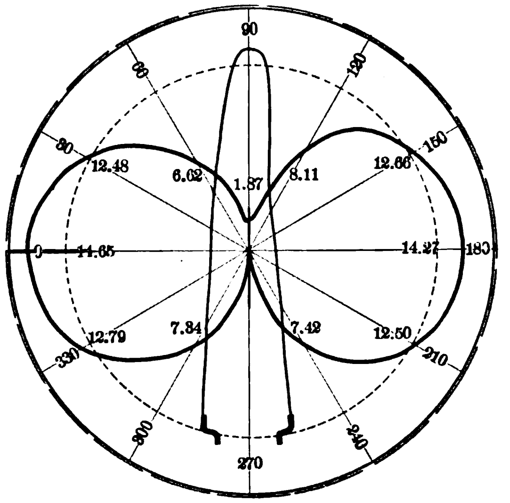
Lamp.—Edison new, 110 volt. 16 c. p. 3.1 Watts.
Mean standard reading = 14.57.
Mean spherical c. p. = 12.34.
Spherical reduction factor = 0.851.
Mean horizontal c. p. = 16.10.
Horizontal reduction factor = 1.111.
Mean sph. c. p. ÷ mean hor. c. p. = 0.767.
Volts = 110.0.
Amperes = 0.4552.
Watts = 50.07.
Watts per mean sph. c. p. = 4.070.
Watts per mean hor. c. p. = 3.120.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = Rect.
Scale of c. p. ≐ 10 c. p. to inch.

Full circle reduced from 3.2″ to 2.5″ in engraving.

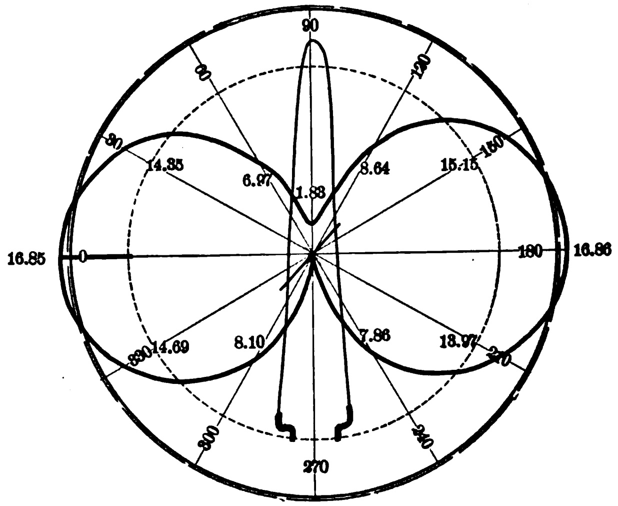
HORIZONTAL



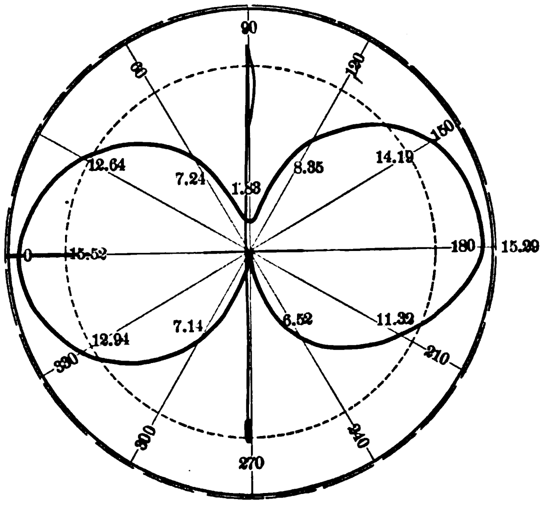
VERTICAL 0°



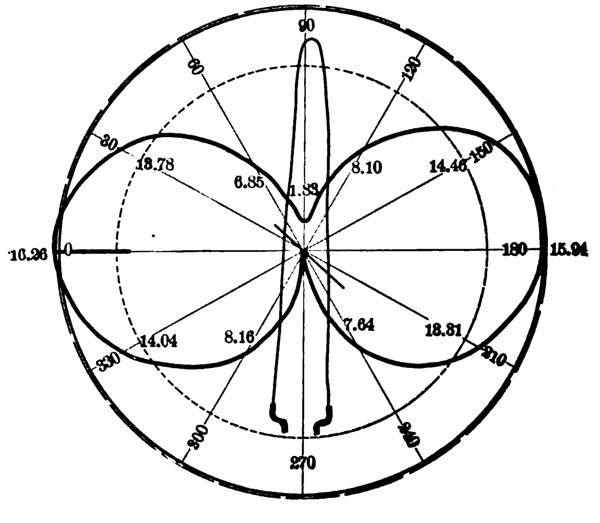
VERTICAL 45°



VERTICAL 90°



VERTICAL 135°

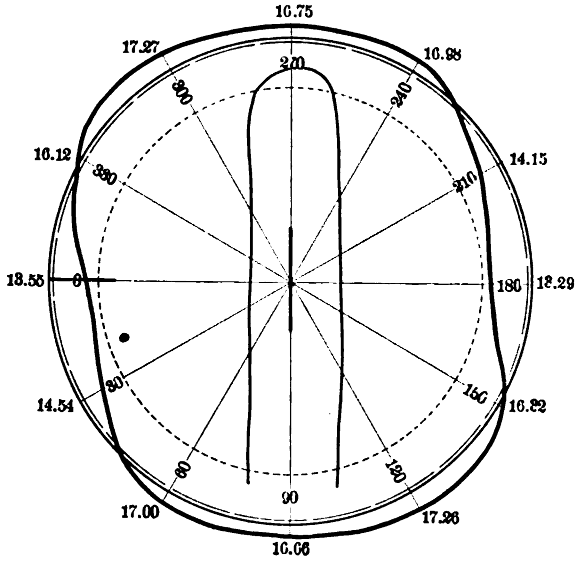


R.—S.—T.

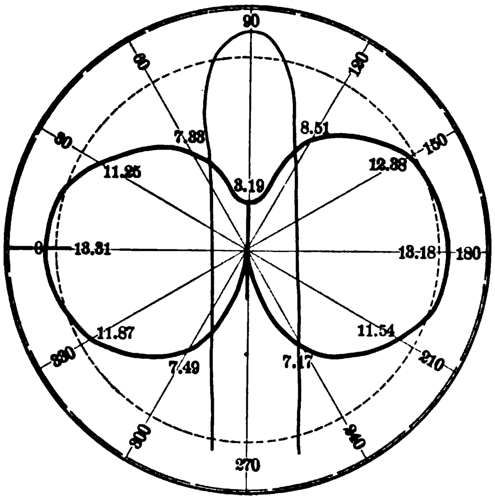
Lamp.—Edison, 93 volt. 16 c. p.
Mean standard reading = 13.38.
Mean spherical c. p. = 12.65.
Spherical reduction factor = 0.947.
Mean horizontal c. p. = 15.83.
Horizontal reduction factor = 1.185.
Mean sph. c. p. ÷ mean hor. c. p. = 0.800.
Volts = 93.00.
Amperes = 0.7240.
Watts = 67.33.
Watts per mean sph. c. p. = 5.325.
Watts per mean hor. c. p. = 4.259.
Rated c. p. = full circle.
Mean sph. c. p. = dotted circle.
Mean hor. c. p. = dashed circle.
Section of filament = Rect.
Scale of c. p. = 10 c. p. to inch.

Full circle reduced from 3.2″ to 2.5″ in engraving.

HORIZONTAL



VERTICAL 0°



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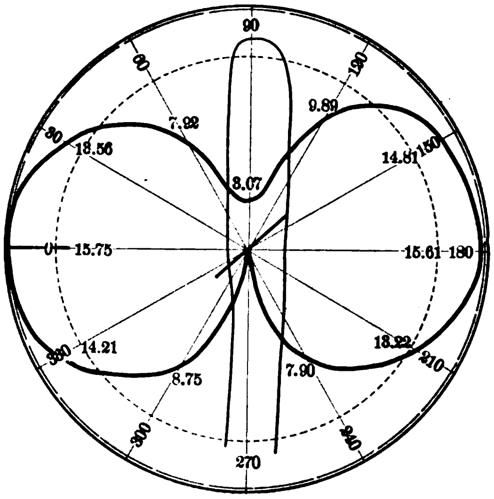
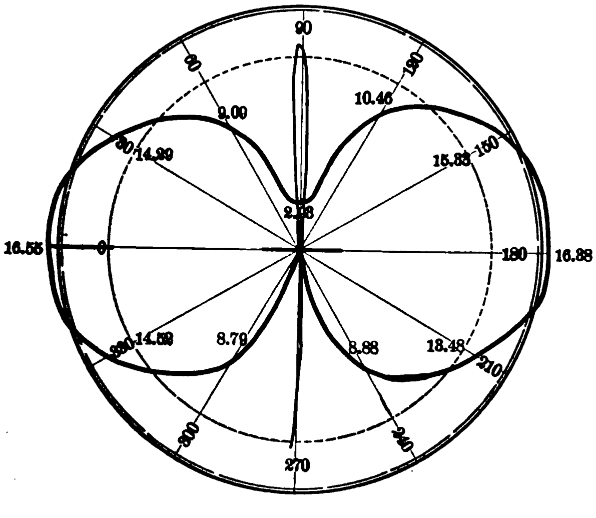
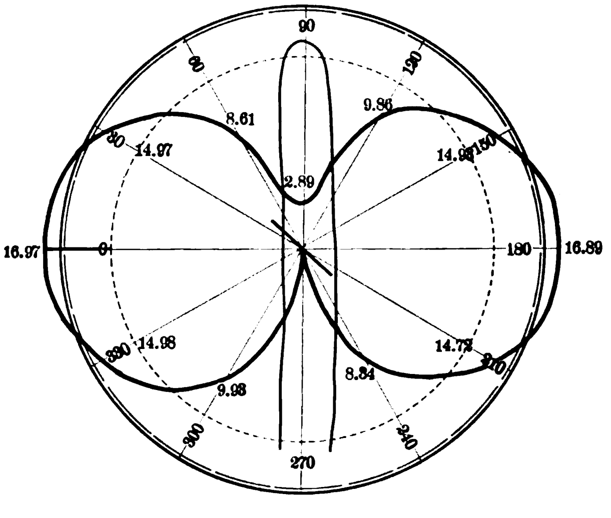


VERTICAL 90°



VERTICAL 135°



THE SHAVER MOLECULAR TELEPHONE.

There are many situations in which telephonic communication is of importance but in which the expense involved in the operation of the electric telephone does not warrant its introduction, and some form of mechanical telephone, therefore, becomes desirable.

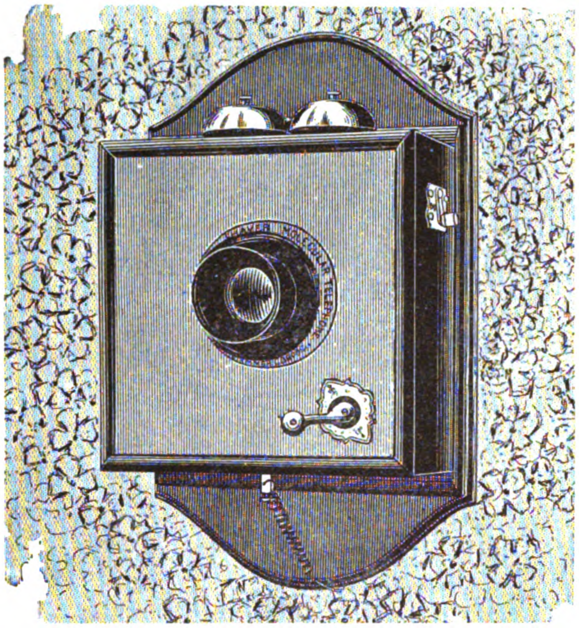


Fig. 1.

Mr. George Frederick Shaver, who has long made the subject of mechanical telephones a matter of study, and is well known as a fertile inventor, has recently brought out an improved form of apparatus known as the "molecular telephone." The principle upon which this telephone is based may be said to be an extension of the well-known phenomenon observed in the transmission of sound through a log of wood, in virtue of which the scratching of a pin at one end may be heard by placing the ear to the other end. Applying this principle to the mechanical telephone, Mr. Shaver employs a peculiarly-formed resonator, which is bell-shaped, and to the centre of which a cable wire of peculiar construction, forming the line, is attached. The outer lip of the bell is held in a vulcanite frame combined with a sounding board, which is so sensitive that by breathing against one of the diaphragms the sound is reproduced at the other end of a line two miles in length.

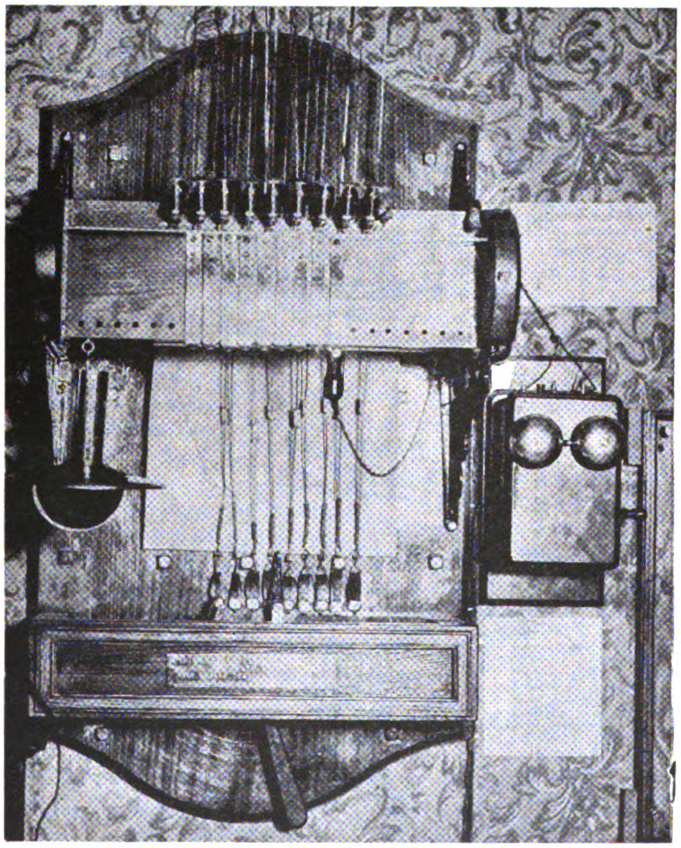


Fig. 3.

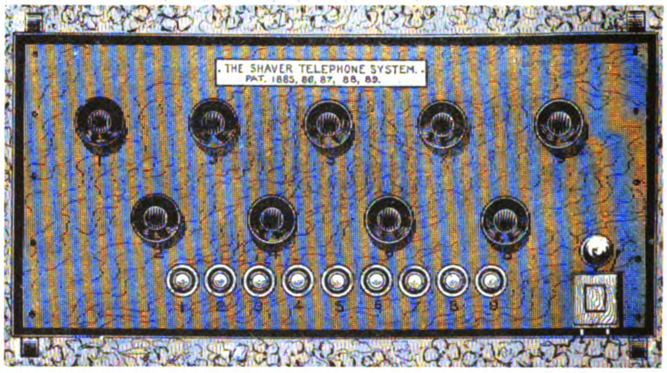

THE SHAVER TELEPHONE SYSTEM.
PAT. 1885, 86, 87, 88, 89.

Fig. 2.

The accompanying illustration, Fig. 1, shows the regular instrument for a single line. It is used both as receiver and transmitter, and is provided with the Gillette magneto call; and these single instruments are well adapted for private lines, and operate nicely through distances of two miles.

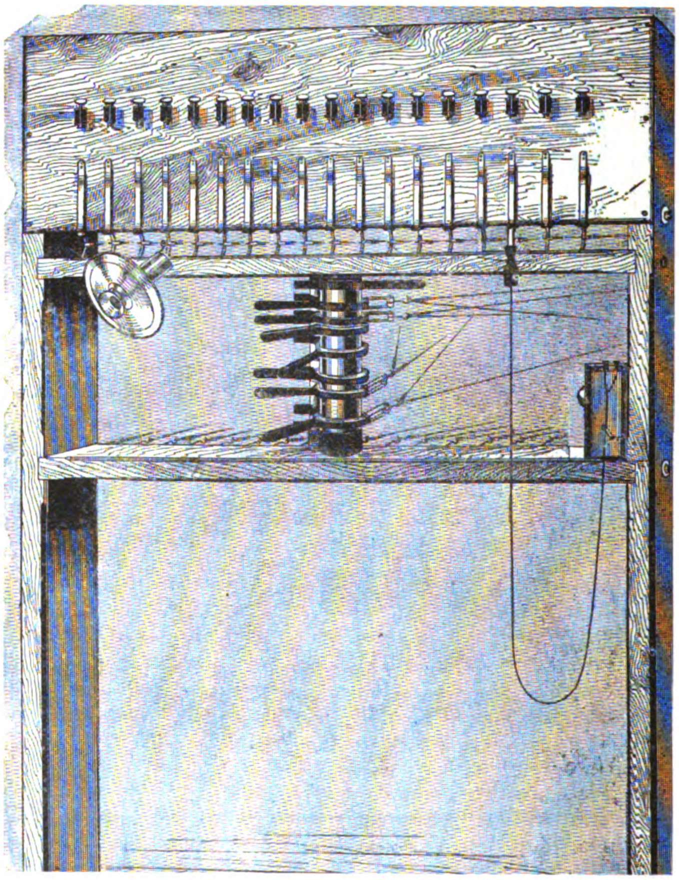


Fig. 4.

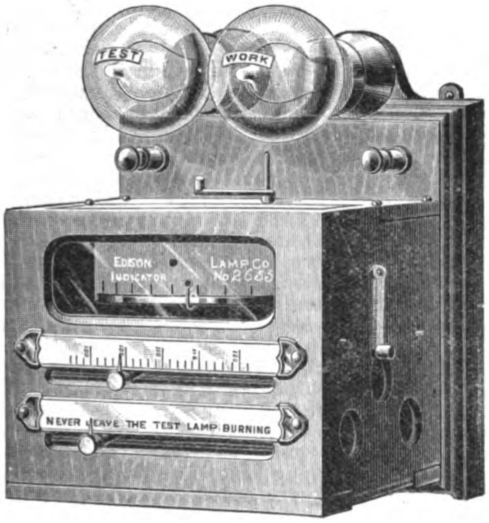
The system is also well adapted for club lines and requires no attendant, each station being able to call up any other station upon the circuit direct. For factory use, one of the arrangements employed is that shown in Fig. 2, which is specially suited to communication between the office of a factory and the various departments. Another form of this apparatus is shown in the engraving, Fig. 3, which represents a telephone exchange system with a switch for connecting different stations together and is specially adapted for inside work.

The system has also been very completely worked out for general exchange work where the number of subscribers does not exceed 100, and is effective within a radius of one-half mile about the station, allowing a mile distance between subscribers. Such an exchange is shown in Fig. 4, and of course requires an attendant to do the switching to connect the subscribers, as in the service now in vogue in the electric telephone exchanges.

We may add that this type of telephone has been adopted by the Lehigh Valley, Delaware, Lackawanna & Western, New York Central and a number of other railroads, and that it has been also approved by the Government for some of its work. The articulation, which we have had occasion to test more than once, is quite clear, the sibilants especially coming out very distinctly. The instrument is manufactured by the Shaver Corporation of this city.

NEW EDISON TWO-LAMP PRESSURE INDICATOR.

Our readers are without doubt generally familiar with the pressure indicators used in connection with Edison isolated plants. These instruments embody in their construction the Poggendorff method of measuring potentials, and one of the resistances employed consists of an incandescent lamp which is constantly in circuit. Experience has shown, however, that the carbon filament in the lamp on the one-lamp pressure indicator changed in time so that it became necessary to recalibrate the indicator in order to maintain correct indications. Hence it was desirable to add to the instrument a means by which the egineer operating the plant could quickly and easily restandardize his instrument.



Edison Two-Lamp Pressure Indicator.

This improvement virtually consists in connecting two indicators through a switch to the same points in a circuit, using one lamp as a working indicator to be kept constantly in circuit, while the other is kept out of use until such time as it is thought necessary to throw it in, in order to check the other. This is done in one instrument by putting on two lamps and two sliding resistances and so connecting them with a switch that when one lamp is lighted one slider is used, and when the other lamp is on the other slider is in use.

In the two-lamp pressure indicator, which is shown in the accompanying engraving, and is manufactured by the Edison Lamp Co., the "Test" lamp is the one which is kept for a check while the "Work" lamp is always in circuit. By this arrangement the engineer in charge of a plant can at any time test the accuracy of his instrument and thus avoid excessive lamp breakage due to the carrying of too high a pressure.

SENDING PICTURES BY TELEGRAPH.

Among the large number of methods of transmitting intelligence the fac-simile has always had a charm for inventors, and the transmission of sketches and diagrams has been accomplished in a variety of ways. Recently Mr. H. Rickinson, of Islington, London, has brought out a method which is based on a principle which has already been applied, but which is carried out to a somewhat minuter degree than heretofore. In this system the original sketch is divided up into squares by means of ordinates and abscissæ, and each square is identified by the letters which are ranged along the sides of the chart. Each of these squares is again divided into five parts, which are identified by the numbers 1, 2, 3, 4 and 5, and each such part is divided into two, and half the part is denoted by the letter *j*. Any point in the picture thus has two co-ordinates, as in analytical geometry, and these co-ordinates are communicated by telegraph. A broken line is, of course, identified by a number of points taken along it. When the sketch has been reproduced by joining the points constituting the lines, the details may be filled in by the aid of the descriptive words added.

THE GANZ ALTERNATING CURRENT MOTOR.

The city of Frankfort-on-the-Main decided during the past year to inquire into the various methods of electric distribution, with an ultimate view to the adoption of the one best suited to its wants. To arrive at a proper conclusion the town council placed the matter in the hands of a committee consisting of some of the most prominent electricians in Europe, whose report has lately been rendered. During their investigations the committee had occasion to test the new Ganz alternating current motor, and the results obtained are interesting in several respects.

On the question of the output and efficiency of the Ganz motor, the committee report that experiments were made with the 25 h. p. and 5 h. p. types. The former gave efficiencies of 82 per cent. to 88 per cent. for outputs of 15 to 35 h. p.; the 5 h. p. showed efficiencies of 60 per cent. to 80 per cent. for outputs of 3 to 8 h. p., the figure for normal load being on an average 78 per cent. The efficiency, therefore, does not differ to any important extent from that of direct current motors.

With respect to starting, it was found that the 25 h. p. motor could not start itself, and the smaller sizes, 5 h. p. and ½ h. p. were unable to do so in certain positions. A test as to starting the motor with full load on was not made, as Messrs. Ganz & Co. objected to it. The time necessary for the attainment of normal speed was from 30 to 45 seconds. The start was always accompanied by heavy sparking at the brushes, diminishing as the normal speed was reached. In the 25 h. p. machine these sparks were 5 cm. long, and 3 cm. on the 5 h. p. machine. At normal speed the sparking was not worse than with direct-current motors.

With regard to noise, the committee pointed out that from the nature of the action, as well as from the sparking, when not running synchronously, more noise was to be expected from the alternating current machine. In factories and on tram-cars this noise was unimportant; but it would exclude the larger sizes of the motor from dwelling houses, unless exceptionally good foundations were secured. With the small motors the noise would not exceed that of the machines used to drive sewing machines with. The motors being synchronous, regulation of speed could only be arrived at by means of multiple-speeded pulleys.

A series of tests was made to ascertain the effect of sudden application of load and of overloading, and it was found that the 25 h. p. motor did not fall out of synchronism till it was loaded with 40 h. p., and the 5 h. p. motor could be loaded up to 8 h. p., in each case a maximum load 60 per cent. in excess of the normal. A sudden load of 26 h. p. can be put on to the large machine when running light, though a heavier load than this suddenly applied will cause it to stop. When running at 26 h. p. a further sudden load of 8 h. p., and after the application of this a further 6 h. p. can be put on, the total load being then 40 h. p. The whole of this load can be suddenly removed without affecting the behavior of the machines. The 5 h. p. machine could take a sudden load of 6 h. p., which in the same way could be suddenly increased to 8. It should be mentioned that the machines tested were the second of their respective classes that had ever been built.

. . . The only money to be made in the future in electric lighting under the coming competition is to be made in saving.—*A. F. Upton.*

. . . . In the past the arts have led; in the future we shall see science leading and directing every development of the arts.—*Professor Robert H. Thurston.*

THE SOCIAL SIDE OF THE ELECTRIC RAILWAY.[1]

BY T. C. MARTIN.

A MONTH or two ago we had the pleasure of listening in this hall to a most interesting paper by Mr. S. Dana Greene on the development of electric traction. I had previously promised the secretary of the society a paper on the same subject, but I felt it would be useless for me to traverse the same ground again. Mr. Greene spoke with authority, and not as one of the newspaper scribes; and I was glad to learn from him and accept most of his conclusions. I recognize the fact, however, that he dealt with the topic mainly on its technical side, as a specialist of experience, and that there was still a very important branch of the subject on which a few helpful words might be said—namely, the relation of the electric railway to the public and to social conditions generally.

Few of us stop to think of the enormous difference that facilities for travel make in our lives. I do not refer to the opportunities and appliances for long journeys, but to the simple everyday transportation that we calmly accept as a prime condition of existence. It is probably safe to say that every one of us came here to-night, and will go home, without depending on our legs to make the trip. But this is altogether modern, and to the generation immediately preceding ours would have seemed as unlikely as that, from total lack of exercise our legs should become atrophied and own no function of pedestrianism. Yet now that we have enjoyed the advantages that the means of artificial locomotion already familiar give us, we want more. The Harlemite does not consider it rapid transit unless he goes from City Hall square to the rocks and goats above Mount Morris park in an hour and a half, and his discontent with the steam railway on stilts becomes daily diviner and deeper. The citizen of Brooklyn is not satisfied to be reduced to a despairing calculation as to whether he is after all better off by being jammed and gouged on the bridge than by balancing on one trodden toe upon the old ferry boats, before he can reach his little vine-clad, mortgaged home at the back of the east wind. And as for the Jerseyman, it is needless to say that of all the ills of his wearisome daily travel, he is able to commute only one. Still, we are infinitely better off in choice of location for our homes than were the people of Manhattan before us, who knew not the elevated railroad, and never gladdened their eyes with the majestic spectacle of the platform of Brooklyn Bridge at a quarter to six on a wet March night, with the cable broken down. If you will take the trouble to invite the candid opinion of the "oldest inhabitant" as to the vanished Broadway stages, the early street cars, and the ancient ferries, you will learn that we have scored a distinct advance. That is why we all want something better.

This is a barbarous age we live in, but we have a foretaste of the civilization that awaits our descendants. We are beginning to learn that luxury is a relative term. A hundred or even 50 years ago there was no such thing as luxurious travel. Washington came to New York to be installed as president, in a manner that a fastidious drummer might now despise. De Quincey was willing to give five years of his life for an outside place on a stage coach that carried down from London through the English counties the news of a great event. We save our five years and our health, and get all the thrill we want, by blocking up the sidewalk on Park Row, and reading the newspaper bulletins as they cover one another on the boards, like successive waves of emotion, rolling in from the unseen but tangible, throbbing distance. We know what the past was. The blizzard of two years ago brought us down to the normal, average conditions of semi-savagery in locomotion as it prevailed prior to the introduction of the steam road, conditions that need all the glamor of the romancist to be made even tolerable as a picture to the New Yorker who boards the Pullman special for the south, and has had his pleasure in Florida, and returned before the storm that was in progress when he left has gone eastward to discover Europe.

What steam has been to long-distance travel in replacing the stage coach and the sail, electricity is in turn to urban travel in replacing the horse car and the cable road. Later in this paper I will indicate the manner in which electricity may sooner or later realize the best and brightest promises made on behalf of the trans-continental steam railroad, but our first thought is as to electrical travel within towns and cities, and the manner in which it affects social relations, by modifying as with the harlequin wand of transformation all the conditions to which we have heretofore been subjected.

In speaking of this great advance in electricity as applied to the comfort and convenience of man, I do not wish to be understood as praising a perfect thing. We are in the early stages of practical electric locomotion. The pioneer work has been done by young men, still among us, much too near their salad days to fall into the reminiscent vein. It is barely three years ago that I had myself the honor of bringing before the American Institute of Electrical Engineers the first statistics published on American electrical railways, when I seized with brazen audacity upon every bit of a track that could possibly bear inclusion as a road. I would be understood rather as appearing in advocacy of an improvement in many respects crude, but that is not yet appreciated even as it stands. We of the electrical industry have a great duty in this respect, of preaching the advantages of electric locomotion, in season and out of season; and by our persistency we can help the art along. The phrase that good wine needs no bush was not coined by an American advertiser, and the idea that electricity will make its own way is not justified by the history of any great invention that has yet subserved the needs of mankind. Electric locomotion is, however, ready for adoption at an opportune moment. It offers itself at a time when every thing else that has been tried for urban travel, has revealed objections and disadvantages, the more keenly realized because of our higher conceptions of what such travel may be. It is a singular principle that as a system or device reaches perfection something comes forward to supersede it. The horse coach was at its height of speed and comfort when the steam engine challenged it. The white-sailed China clipper was never swifter than when it lowered its flag to the conquering steamship. And so to-day, the horse, the cable and the steam locomotive have shown the utmost that they can do, just as the electric motor rolls to the front and takes the stage, as the means best suited to the peculiar requirements of passenger traffic in modern towns and cities. I do not say that it will banish these competitors from the scene, but I do maintain that its superiority will quickly gain it the decided preference. I am always suspicious of an invention or improvement that is going to knock out everything else, like a charge of dynamite. History is against any such phenomenon. What we do see is a limitation of the antecedent methods and appliances to the sphere within which they are most useful and economical. The old is restricted to its proper place and function as by a ring of fire; the new goes on making its own kingdom until at last its boundaries of achievement are also determined. Thus, as Tennyson puts it, "God fulfils himself in many ways, lest one good custom should corrupt the world."

The first of the social considerations to which I would direct notice is the effect on the public of the adoption of electricity as a motive power for street railways. The struggle for supremacy in urban passenger work has already narrowed down strictly to the horse, the cable and the electric motor. As everybody knows, steam motors are completely out of favor for use within city limits. Their glorious record of half a century in long-distance travel does not deceive anyone dwelling in a city as to the insuperable defects and nuisances of noise, smell, smoke, dust, steam escape, oil drippings, etc., which may more readily be tolerated, remotely, in the open country. Perhaps I am wrong, but I believe we shall not see any more steam roads in New York, and that imposing as are the statistics of the Manhattan elevated system to-day, they will be eclipsed in a very few years by those of the newer form of electric locomotion. And may not the same be said as to the horse? There are now close upon 15,000 horses engaged in hauling street cars around this city. It is high time that every one of these was dispensed with, as well for its own sake as for that of the city, whose air it assists in polluting and whose population it aids in driving into exile. Allowing an average space of 40 square feet to each horse, or a stall 9 feet by 4½ feet, we find that in stall space alone those 15,000 horses occupy 600,000 square feet of floor in their stables. These horses are required to operate some 2,400 cars, an average of about seven to the car if every car were in commission at once, which is not at all the case. But even if nearly all the cars were wanted, an average of 10 h. p. each would be ample in the central station of an electrical plant, bringing us to a liberal allowance of 25,000 h. p. But here comes in the remarkable though not unfamiliar fact that a steam plant will go into much less space than an animal power plant of equal capacity. Mr. C. J. Field, who is known to many of you as a constructing and mechanical engineer, informs me that his recent practice shows that a generating electrical plant for 20,000 h. p., to operate all the street cars of this city, could easily be placed in a building 100 x 150. The engines and the dynamos would be placed on the first floor, and the boilers on the second floor. The generators in such a plant would be multipolar, 500 h. p. each, directly connected to the engines, and each engine would be of a vertical triple expansion type, of 500 h. p. each. This gives only 1½ square feet to the horse-power, and we may offset the space for feed, etc., by that for coal, etc. I have tested these figures by those of recent electric light stations in actual operation, and they are found to be very fair and reasonable. It might be objected that all the power would not be bunched in this way; but even with half a dozen generating stations of 2,000 h. p. there would only be an increase in space required of about ten per cent. From this remarkable but strictly proper comparison, we can form an idea as to the economy of real estate, bearing in mind also the fact that horse car stables are generally wooden or brick sheds, only one or two stories in height, while an electrical plant may be run up as high as an apartment house or an office building, just as ornate without, just as clean within.

Hence there can be no mistake in the statement that electricity is a direct boon to the urban population that clings to the city, loves the city life, and that if crowded out from it into the country suffers all the pangs of banishment. Indirectly, too, it is a further boon because with horses a great portion of the district surrounding the car stables is also spoiled for human habitation. The whole region within what I would define as "the area of smell" is unsavory and unhealthy the year through, and the consequence is that while the taxing and renting value of it is lessened, the death rate is run up. "Do not insult a respectable animal who has come from the country to do his share of the work of the world," says one authority, "and has brought with him the memory of the sweet hills and skies at least, by immuring him in one of those cramped, rickety, rotten, slovenly, damp dungeons, where a dumb beast would lose his self-respect and his courage, beneath an oppressive weight of miasma, and hideous, gloomy, nasty confusion." And so say all of us, and all of us are glad to note a vast improvement in this respect. The stables are better ventilated now as a rule, but the trouble is just there. If they were not so well ventilated, the neighborhood would be sweeter, and would be fitter for human beings to live in. The poor die quicker that the horses may suffer longer.

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[1] A paper read before the New York Electrical Society, March 12, 1890.

An objection I may anticipate is that, after all, such large generating plants would not be desirable with their huge smoke stacks, their discharge of gases, etc., upon the atmosphere, their receipt of coal and their removal of ashes. I would reply that it is by no means necessary for such plants to be, as the stables must be, right upon the main lines of travel. They would by decided preference be located near the water's edge, out of the way. Moreover, the stacks would be, as they are to-day in large electric light plants, high enough to carry off all smoke or smell far beyond perception. Perhaps the familiar smoke stack is not an æsthetic object, but it can be made so. There are steeples in this town that on the score of their beauty are not fit to compare with smoke stacks near them.

Much that I have said under this head with respect to electricity applies to the cable. That system has been an immense advance in street car travel, and is destined to many years of usefulness yet. It is worthy of much praise; but it will not hold its own with electricity, simply because it is deficient in some things that electricity possesses to a pre eminent degree. It has been a forerunner for electricity. It is not only enormously costly in its first installation, but has the disadvantage of being a unit. The whole of the road and all its power hangs by that one cable. If the cable be duplicated in the conduit, the expense is again so much the heavier, while the criticism as to risk still stands. Moreover, a cable car cannot go backward at its driver's will. Onward it must go, Mazeppa-like, strapped down to its carrier, no matter what unfortunate contingency impend, or what obstacle lies in its path. It cannot greatly vary its own speed. An electric car is so manageable that it will reverse in its own length or less. But the greatest trouble of all with the cable is that it is always the one thing, while there are very few towns or cities that are alike in offering just the rigid Procrustean conditions it meets. There are about 50 cities in the United States with a population of over 50,000, but there are between 700 and 800 street railway companies, if not more; so that even if all the places in the first category could justify the heavy expenditure on a cable system, there are hundreds of others unable to do so. We need not wonder then that at their last convention in Minneapolis, the street railway men gave electricity such a hearty welcome, adopting the enthusiastic if not elegant language of a committee report which said that it "filled the bill to perfection." Nor need we wonder that the street railway company in Minneapolis has just thrown aside an unused cable plant that cost $400,000, and is putting in electric cars and over 100 miles of electric road.

Why does electricity "fill the bill," and in a manner that interests the public? Well, for the reasons given already and for others. It is above all things flexible, plastic, protean. It can be applied in half a dozen different ways, and be absolutely safe for human life in any and all of them. The street railway may be equipped with an overhead system for supplying the current to the motors, and to that system, well built, with trim ornamental poles, lines well run and guarded, little or no objection can be offered. The air is God's own insulation; we know none better, none so cheap, and a wire is well insulated up aloft. The Bostonians, who are people setting no small store by their refined, acute and cultivated taste, have adopted poles and wires in preference to the hideously ugly lattice work tunnels we have in New York to hold up our elevated roads, and I admire them for it. It is possible that Boston may have an elevated road, but if so it will be a handsome electric one. Or, if the overhead wire be objected to, as it may, there is the conduit system, which is fully able to give a good account of itself if well put in and plenty of money be spent on it. It is true that the wires are not exposed in the conduit system, but otherwise there is not much operative difference between it and the overhead method. There may be difficulties in heavy wet, or snowy weather, but we shall see them all overcome. Or should this or its modifications again be found fault with, there is the ideal storage battery system, where each car starts out "on its own hook," an independent, self-contained unit. I don't exactly know why we call it the "ideal system." It is either within reach or beyond. If within reach, it is not "ideal," but ought, speaking from the public standpoint, to be adopted wherever there is actual need for it. It may be a trifle expensive, but that is certainly not one reason more why the public should do without it. It may be somewhat difficult to put and keep in order. "Coaches, Sammy," said the elder Weller, sententiously, to his son, "coaches is like guns—they require to be loaded with werry great care afore they go off," and that is about the case with the storage battery cars. But they do go off, and we know from the approval they have met with that they do hit the mark of popular approval,—and that is one of the main things I am talking about to-night.

It is in one or other of these systems or modifications of them that electricity will become familiar to the public of this country in street railway work. It will, I think, be chiefly for a long time to come, the overhead system, which is not costly to put up, is not expensive to maintain, can be operated economically at about half the running charges of animal power, and fully answers the requirements of the vast majority of our thriving, intelligent centres of trade and manufacture. All these methods are safe, and none of us ever heard, or expects to hear, that the current of 500 volts they have employed has taken a single human life. The motor cars cannot "explode," the daily papers to the contrary notwithstanding. They scatter no dust or ashes; they do not litter the streets with offensive refuse, but rather ozonize the air; they are pleasant to ride in and they do not damage the paving. They require good tracks for their best operation, and naturally make their worst showing on the automatic mud sprinklers that so begutter the roadways in this city. But the roadbed between the tracks they never touch. It might as well be a continuous plot of flowers. In the outskirts of Boston, some of the electric cars whose aerial wires run hidden between the overarching trees, have their tracks laid down on a narrow green lawn for three or four miles; and at a remove of but a few feet, it seems to the spectator as though the cars were gracefully skimming over the smooth grass, in effortless flight, like low-darting, even-poised swallows.

I have just spoken of the outskirts of Boston, and this brings me to another important point wherein electric cars are an element making for the public good. They help a man to get farther away from his business, and yet bring him nearer to it. "Rapid transit" by their means is no longer a deceiving phrase, or the proud monopoly of one or two big cities. The smallest city in the country is at once given a command it never had before over the territory around it. The smallest store keeper or the humblest clerk can revel in the sweets of rural life, if he wish. His electric car, running at 15 or 20 miles an hour, will give him more of home life—a few golden minutes with the children in the morning, an earlier return to the wife at nightfall. The whole social atmosphere of the place is vivified, and the social bonds are knit closer, as they always must inevitably be where the facilities of travel are increased, and the opportunities of intercourse are multiplied.

Nor is this all. Rapid transit of this nature opens up a number of districts that before were practically inaccessible for residential purposes. There are few of us who care to practice the ancient form of dissipation known as early rising, agreeing rather with Charles Lamb, in the idea that to rise with the lark or go to bed with the sheep is a popular fallacy. There are still fewer of us, who, even for the sake of rural delights, care to isolate and immure ourselves in remote suburbs reached with difficulty. In vacation time, it is true, we often seek the loneliness of the woods, or the solitude of the mountains, that we may commune with Nature and hear the still small voice of our better self; but when we are doing the world's work 50 weeks in the year, we want to be handily situated for reaching our desk or bench. If a man lives in the city, he pays a high rent and takes Irish views of the landlord question. If he lives far out, and wastes his time in travel, he is in hearty sympathy with the eight hour movement. I look upon electric roads, therefore, as likely to prove a beneficial agency in the more equal distribution of a happier population around any centre, thus increasing the return on outlying property, while, by the encouragement of retail trade, enhancing the profit of the area lying within the region thereafter more legitimately restricted to business occupancy. I have watched with much interest the manner in which electric roads have already thus developed suburban areas. Booms are not a particularly healthy feature of progress, but they may be, and not infrequently are, genuine and real; and I know nothing more likely to bring on a real estate boom of the best character with permanent results than the installation of a well-managed electric road, enabling a man to leave his work at 6 o'clock, and be sitting down to his supper seven or ten miles out, if he wish, under his own roof-tree, at 6.30.

Having thus discussed the effect of electric roads on the community and on the individual citizen, I will add a word as to their effect on the wonderful impersonal entity, "capital." If all that I have said be true as to the general benefits, it follows that the wealth and ease of the community are materially increased; but what I refer to now, is not the direct enhancement of values, so hard to trace out, though so palpable, but the stimulus given to saving habits by the better opportunities of investment. Careful analysis of the working of electric roads goes to prove that when operated with skill and discretion, they are 50 per cent. less expensive to run than horse railroads are. What does this mean? One thing it means is that many roads can be built that would be out of the question with horses. Another is that roads not paying can be placed on a dividend basis. In 1888, out of 19 horse roads reporting in New York city, 10 showed a deficiency. Last year their net earnings were much better, but it is evident that a horse road is not always a mine of wealth, though it may be of fertilizers. A third point is the establishing of a new class of investments of a solid, enduring nature. It is within everybody's knowledge that the accumulation of capital tends constantly to the reduction of interest to a minimum. There was a time when the long stocking and the iron chest were the common bankers for the savings of the timid; and the capital that was bold earned the double reward of its bravery and scarcity. As Walter Bagehot, the economist, has remarked, the English people have always wanted to put their money into something safe that will yield five per cent.; and this is undoubtedly one reason why English capital, free and fluent, is so much a power in the finance of the world, and why so much comes this way. As Mr. Bagehot says:—"In most countries, most men are content to forego interest; but in more advanced countries at some times there are more savings seeking investment than there are known investments for." It is thus in America, so far as "safe" investments are concerned, and by safe I mean such as do not require the active care and ceaseless thought of the capitalist, but may be held by trustees, widows, hospitals, universities, savings banks and the like. The competition of capital for the best class of government bonds, municipal bonds, railroad stocks, &c., has reduced the earnings on these to a very low figure, whether in America or England or Germany; and the result is that we see to-day, as never before, the planning of enormous trusts and gigantic industrial enterprises, which represent in no small degree the endeavor of capital, or savings, still to enjoy its wonted income, but in newer fields. Now I look upon the street railway business of the country, under the regime of electricity, as offering one of the best opportunities for local capital, and for what may be called the organization of local savings, which might otherwise lie around in napkins, like the unjust steward's talent, and be of no use to anybody. The capital in street railways in America to-day, reaches from $175,000,000 to $200,000,000. If the statement I have made as to the superior economy of electrical power be true, how much greater becomes the earning capacity of this investment, and how much greater are the attractions held out to construct the hundreds of new roads that are still wanted and will be called for as our towns and cities grow. Of course, I am aware that it may be said that this showing might lead to a demand for lower fares. It might, but the public is intelligent enough to know that other things are more necessary, such as better cars, with better heat and better light; improved tracks, faster running time and shorter headway; so that the 150,000,000 passengers on the street railroads every year may travel in all safety and comfort. Street railroads are peculiarly suitable as a field for local investment. Their operation can be watched all the time. They run under a man's eye when he is on the street, or past his window when he is home. He knows something of their officials; he can influence the domestic legislation they are subject to; he can assist in more ways than one to swell their earnings.

The next important point to which I would direct your attention is the effect that the electric railway has upon the employés of the service. It cannot be denied that the introduction of electricity in this respect marks a decided advance in the social condition and aptitudes of a large body of men. I have never yet met with anybody or anything that could place the work of a horse car driver in a favorable light. One certainly could not fairly expect a man who spends the day with his nose at the tail of a car horse to realize a very high ideal of life and duty, especially when the whole of his work is done under conditions exhausting alike to temper and physique. It is out-door exposure the whole time, whether in summer heat or winter blast. Half the time it is an exercise of sheer brute strength, and no car driver believes in his heart that a horse-power is only 33,000 foot pounds a minute. His aching wrists and dislocated shoulders tell him that Watt was far below the mark in putting it at that figure. And then, the worry of the street traffic. We have all of us noticed the conscientious persistence with which draymen and coachmen will keep on the car tracks in front of a car. An investigation made two or three years ago in Chicago showed that at one point in the streets there, 97.6 of the street traffic sought the railroad, while at another it was 87½, and at a third, 90 per cent. Against such odds the driver with his restless or apathetic team has to make his way and keep to the running schedule; fighting all the time with the fear of an accident either to his car or to some hapless foot passenger.

With an electric car, the matter is not one of muscle and brawn, but of average intelligence and ordinary readiness of decision. A better class of men are wanted and forthcoming, or the same men are relieved from physical wear and tear, and thereafter can earn their bread in the sweat of their brow and not that of their body. A woman might easily run an electric car. The motorman gets instantaneously by the turn of a switch the exact degree of power that he wants; he can apply his brakes readily; and if he needs to run backward up-hill he can do so, sitting down at his switch. It is not necessary to expose him to the weather. His fears as to running people down are materially lessened by the gain in control of the car and by the further fact that an electric car takes up only half the space on the street that a horse car and its team do. The work is not less safe than cleanly. You may remember that when steam roads were started in South Carolina, one of the negro drivers tied down the safety valve and then sat on it. As a result, cotton bales were placed between the locomotive and the coaches to protect the passengers in case of explosion. The new driver was, however, still on the wrong side of the bales. In electric cars both driver and passengers are free from harm. John Bright once said that the safest place on earth was a first-class carriage in an express train; but to-day it may be fairly affirmed that no vehicle can compare as to freedom from danger with the electric street car.

A feature of this refinement of the work is that it must necessarily be attended by better pay for the higher intelligence and skill. Mere brute strength does not command good wages nowadays, except in a prize fighter, and the further we get away from animal conditions the better do we find the status of the individual or the occupation to be. The remarks made above as regards the drivers apply equally to the staff at the generating plant. People sometimes wonder why there are so many hostlers around car stables, but when you remember that well-kept car horses work only two hours and a quarter daily, you will see that they need a good many attendants at the stables during the other 20 odd hours. In place of these grooms and hostlers you have, with an electric plant, a skilled force of steam engineers and mechanics, each trained for the special function which the principle of the division of labor has shown him to be best qualified for.

And here let me inject the pertinent remark, that this new and successful development of electricity is one reason more why the mechanical engineer and steam engineer should master electrical principles and practice, whether for the higher walks of his profession or for the humbler duties of running a plant. The coming of electricity, and its application to light and power, has afforded a grand stimulus to steam engineering in every department, and may not improperly be claimed to have created the modern high speed engine. Sir William Thomson has said that the electrical engineer is nine-tenths a mechanical engineer. To this I will add a corollary, and say that the mechanical engineer may be a master in these new electrical fields if he will only add the one-tenth to his education. The time is at hand when the mechanical engineer will not be considered worthy of his name or his calling unless he is also an electrical engineer, as familiar with Ohm's law as he is with Carnot's or Mariotte's.

Incidentally through this paper I have referred to the effect of the electric railroad upon horses. It has, indeed, been most gratifying to see how readily the electric railroad has rallied to the support of the Humane Society. It is a humane society itself. Whether he wished it or not, the electrical engineer in this instance is conferring a great boon on the horse. We sometimes do the greatest good, as we do often the greatest evil, unconsciously, rather than of set purpose; and so, here, the inventors of the modern electric motor and the electric car have released the horse from one of the most painful and exhausting services that it was ever put to. Investigations over a long period have shown that with the pavement dry a horse would meet with an accident in every 78 miles of travel on granite; in every 168 miles with the pavement damp, and every 537 with the pavement thoroughly wet. Unfortunately for the horse, though happily for the rest of us, the first two conditions generally prevail on our streets; and hence the horse has a poor outlook as to accidents. But it is not the accident the horse has so much to dread, after all, as the constant strain and the pull of a heavy load from its dead rest every few hundred yards. It is generally admitted by street railway men that car horses fail because of this feature of their work, and that it helps to cut down their railroad life and utility to the average of from three to five years. If you want to see these conditions at their worst, take Broadway, once our pride, now one of the most overrated thoroughfares in Christendom. The pavement is abominable, and the horses, like the foot passengers, can be seen struggling for a grip on the uneven, slippery stones, all the way from one end of it to the other. The traffic on the street is so great that I have noted full cars making a dozen halts and starts from dead rest between Chambers and Barclay streets,—two blocks. It does not require an expert to foresee the effect of such wear and tear on animals. In Cincinnati, recently, on installing an electric equipment, a street railway company advertised its horses for sale for family and carriage purposes. I have not observed any such advertisements in New York city. The street railway managers are more modest or more truthful here than they are on the banks of the Ohio. The only persons likely to regret seriously the departure of the street car horses from this city would be the horse dealers and feed supply houses, and possibly the street cleaning contractors, though they get their pay anyhow.

I might point out that as a further offset to this displacement of a certain amount of labor in an elementary form, whether that of the horse or the human being in charge of him, we have the stimulus given to a higher class of labor, not only in the station engineer, and motor car driver, but in the electrical expert and inventor. Society benefits greatly by this, just as it does by the superior skill and efficiency implied in the maintenance of such a system as that of the Pennsylvania Railroad company. The running of express trains and fast steamships demands the exertion of the best qualities of a man, as well in the conception of ideas of improvement as in the details of solid construction and vigilant management. Here, therefore, we strike at once into a new field of design and invention, one that promises to be as large and fruitful as any other known to the application of electricity. There have already been several hundred patents taken out on the special subject of electric railways, and the whole air is alive with rumors of the ideas and inventions assuming shape. In a year or two it will be a wise motor that knows its own father. Each new step is a prophecy of a dozen more. Each new patent is a "father of its country," a germ of endless fertility. We begin to learn our resources. "Is there any load that water cannot lift?" asked Emerson, "If there be, try steam; or if not that try electricity. Is there any exhausting of these means?"

Now and then I hear the objection that people would be the quicker to adopt electric locomotion if it were not so beset and made costlier by patents. This is not true, and I have no patience with the spirit that begrudges the inventor his reward. Why do we use the great inventions? Simply and solely because they effect an economy for us in some way or other, chiefly in time or money. If they did not, we should care little about them, and the inventive geniuses of the day would be mere common clay to us. But, on the contrary, the inventor is revered and admired, and is encouraged by the wealth and fame he can earn. Occasionally one hears the expression of an idea that the inventor is wanting in public spirit and devotion to science because he takes out patents and does not invite the world to revel in the riches he reveals while he is content to starve over a crust in a garret. A few weeks ago, Mr. Edison told me that he had found one of his greatest intellectual pleasures in reading "Evangeline." But why should it be less public spirited for Edison to secure a patent on his phonograph than for Longfellow to obtain a copyright on his poetry? Why should not Bell have a patent on the telephone when Victor Hugo protects his "Notre Dame?" Is it not as right for George Westinghouse to derive a princely income from his life-saving air-brake as for Gilbert and Sullivan from their comic operas? Shall not Elihu Thomson enjoy some revenue from his new art of electric welding, as well as Bronson Howard from his "Shenandoah?" It is time that the ideas on this subject were set in the right perspective. Our inventors enjoy the benefits of the patent system because, like the novelists, the poets, the musicians and the artists, they are public benefactors. They promote the public welfare, add to the public comfort, increase the public wealth. The field of electric locomotion will be but one more opportunity to demonstrate this truth. There is no patent on the horse, but the patented electric motor can beat him on every point every day in the week.

Such then, are some of the reflections to which our subject invites us, at this early stage of its development, and there is but one other point to which after this section, I shall refer in closing. Before I leave the electric street railway, I would again say as I said at the outset, that I am not presenting this latest application of electricity as perfect. It is not; on the contrary it is in development and improvement under our very eyes. It is endeavoring to harmonize with its environment. The questions and problems that it opens up are very much like the concentric shells of the Chinese ivory puzzle balls; and we have not yet reached their core. It has one or two family quarrels on hand. The telephone is hardly yet on speaking terms with it. But we know fairly well where the solution of each difficulty lies, and we are on the way to it. Nor am I in any sense an apologist for the shortcomings of our pioneer work. Electric railroad men have made mistakes, are making them now. That cannot be helped. Heaven save us from the men who cannot make mistakes; they will never learn. The conditions in electricity as an industry change with lightning rapidity. A Russian general once remarked of the political situation in Central Asia, that it changed every minute; and so it is in regard to the onrush and uplift of electrical discovery and enterprise. This very fact explains why much of the earlier electric railway work has been of an unfinished, unkempt kind. Mr. Charles Francis Adams, some years ago, in his interesting little work on railroads, said:—"It is a matter of curious observation that almost uniformly those early railroad builders made grave blunders, whenever they tried to do their work peculiarly well; they almost invariably had afterwards to undo it." This is not an excuse, however, for slovenly work. It is better to make blunders trying to do well than in lazily neglecting one's duty; and though it hurts a man who built for eternity to see his work ripped out in five years, he has the serene, sustaining consciousness of right effort and honorable performance. The electric street railway will the sooner achieve its social destiny if the engineering done upon it be the highest and best that the art at each instant will allow.

The topic I have reserved for brief final mention is that of electrical long-distance travel. This is the department of the subject in which imagination has not yet sobered down into invention. Our fancy still plays around the possibilities, and so far from realizing the social side of teletravel, people have not yet awakened generally to the idea that it has any serious, practical side at all. Our patriarchial poet, Whittier, expressed his surprise a month or two ago in his "Burning Driftwood," when he wrote:—

> "Far more than all I dared to dream,
> Unsought before my door I see;
> On wings of fire and steeds of steam
> The world's great wonders come to me."

The steeds of steam are now an old familiar story; but the mechanical Jay-Eye-Sees of the coming day bid fair to be those with "wings of fire;" and then our speed may be something more nearly approximating that of light. It is amusing, however, to see how quickly our generation has become accustomed to teletravel. Did not the Royal College of Bavarian Doctors seek to forbid railway travel because it would induce *delirium furiosum* among the passengers, and drive the spectators crazy? Did not an English quarterly say: "We would as soon expect the people of Woolwich to suffer themselves to be fired from one of Congreve's rockets as to trust themselves to the mercy of a machine going at the rate of twelve miles per hour?" And did not our own General Webb in 1835, after a railroad journey, with ladies, from Boston to Providence, exclaim in horror: "To restore herself to her caste, let a lady move in select company at five miles an hour, and take her meals in comfort at a decent inn." Such alarming and conservative extracts have a familiar sound, perhaps, but I can assure you that they are positively of the ancient date mentioned and not extracts from recent New York newspapers. The fact remains that to-day we have ceased to regard a speed of 60 miles an hour in railway travel as extraordinary, and are casting about for the means with which to attain a higher rate even than 75 miles, of which record was made in 1886, on a short run. This acceleration is, it appears probable, to be found best, or only, in the use of electricity, for the reason that the electric motor may drive directly on the axles, that it need not offer much resistance to the air, or smash the track, and that it does not have to carry its own supply of fuel and water. There are men in this audience who have seen such an electric locomotive making with ease 120 miles an hour, and who propose to propel it at 180 miles an hour. If these things be so—as they are—we know that with electric teletravel, the public will have to accustom itself to strange new conditions, exceeding in scope and power those of the last fifty years. The change will come in our time, and the present telegraphic and telephonic facilities are but an education for it. When we can talk instantaneously with friends in Boston or Philadelphia over a wire, we resent the inadequacy of the means of fast and far locomotion that should enable us to meet them face to face if we wish to do so. When we see electric cars in our streets traveling easily at 15 and 20 miles an hour, and know that on a clear, unbroken, straightaway track we could go from New York to Philadelphia or Boston with the same agency and kindred apparatus, in about an hour, American ingenuity and enterprise will not rest until the thing is done. That will be the first stage in the next evolution of travel.

At the present time electric street railroads are running or building in nearly 150 of our towns and cities, with some 2,000 cars on about 1,200 miles of track. So far as urban traffic is concerned, the new departure has been made. Electric locomotion is with us, an assured fact, the most civilized form of travel, as the electric light is of illumination and the telegraph or telephone is of communication. Already over 150,000,000 nickel ballots are being cast yearly in its favor, and the welcome to it is universal. In the northwest that brand-new cable plant costing $400,000 has just been thrown aside to make room for it. In the south, it is saluted with the exclamation of the delighted darkey,—"First dey freed de negro, and now dey freed de mule." In New York we are waiting on Providence and the aldermen, but we shall not be satisfied till this city is abreast of other progressive communities in the adoption of that which has given, in so short a time, so many proofs of its ability to promote in every respect the highest social welfare of the citizen.

The address was followed by the exhibition, with the aid of the magic lantern, of over 50 views of electric roads in as many American towns and cities, and of the leading systems. These views were explained with running comment.

.... THE grand truths of physical science should be the talk of every schoolboy.—*Professor W. A. Anthony.*

.... IN every well-regulated boiler room, each day's coal should be weighed, not guessed at.—*A. F. Upton.*

.... IF the army of would-be inventors could enter the field with a full knowledge of what science has already done, the conquest of new territory would be still more rapidly accomplished, and not a few of those whose names would be remembered, would be found to have come up from the utilitarian ranks.—*Professor W. A. Anthony.*

ENGLISH AUTHORITIES ON HIGH-TENSION UNDERGROUND CIRCUITS.

During the recent sessions of the New York Senate Committee, which inquired into the condition of the electric lighting circuits in New York city, there were submitted to it the answers given by a number of prominent English electricians to a series of questions, relating to the practicability and safety of underground high-tension circuits. These questions were prepared by Professor Henry Morton. and the answers to them are on file in the Stevens Institute of Technology. As the questions are of general interest at this time, we print them below together with the answers given to each :—

Q. 1. *Can high tension direct and alternating currents for lighting and power purposes be safely and successfully distributed by means of underground cables? If so, up to what voltage can this be done?*

Sir William Thomson—Yes, I believe so, up to 2,500 volts.

Professor George Forbes—We have ample proof that high pressure electric currents, either direct or alternating, can be distributed safely and successfully, for lighting purposes, by means of underground cables. Our experience in the past has been limited to 2,500 volts, as a maximum, and up to this pressure there has been no difficulty whatever, in any case where care has been taken to secure a good and durable type of insulation to the conductors, and to protect them from mechanical, chemical, and other sources of deterioration. It would be unwise to hazard an opinion as to the highest pressure which can be properly used in underground electric mains, until we have experience to guide us. While we have ample data as to insulation and durability under ordinary conditions, yet there are certain phenomena, of whose existence we are aware, when very high pressure (say 10,000 volts) are used, which may, or may not, create difficulties with these high pressures. Until we have further experience, I would not advise any one to run the risk of making the supply of current irregular through defective insulation, and for this reason I would not recommend, at this date, the use in underground mains of a higher pressure alternating current than 2,500 volts, except in way of experiment.

Dr. John Hopkinson—It has been conclusively proved that alternating high tension currents can be supplied without inconvenience by means of underground conductors if the work is properly done; it has also been proved that this can be done with a potential of 2,400 volts. So far as I know it has not yet been proved that a potential of 5,000 volts can be safely used. This potential, however, is now under experiment.

W. H. Preece—I see no difficulty whatever in maintaining such a system of distributing currents by underground cables, and I form that opinion from actual experience and not from mere theory. Underground cables are safe, durable and efficient. I have had full experience of a high pressure alternating current system in Eastbourne, where such a system working with a voltage of 1,800 volts has been at work since 1886, without a single accident or failure, and is now feeding 2,600 lamps. A similar system of which I have had similar experience has been applied in London at the West Brompton Central Station; 1,800 volts have been distributed for over twelve months through 16 miles of underground wire for lighting purposes throughout the rich and flourishing neighborhood of Kensington without a single failure.

I have been a persistent and consistent advocate of the high tension system of distributing electrical energy for many years. In a discussion which took place at the Society of Telegraph Engineers and Electricians on April 24, 1884, I said :—

"I do not think it is practicable or possible with the figures before us, to light up large areas on any such plan as that which has been conceived (a low tension system). It has been departed from in America, it has been departed from in suggestions here, and the day has come when, if electric currents are to be distributed for economical purposes, for lighting or other purposes, they are not to be distributed by enormous conductors swallowing up capital and ruining everybody, but they are to be smaller conductors in which high tension currents can be utilized and distributed. It may be by secondary batteries, when secondary batteries are made practical. It may be by secondary generators such as we have seen attempted on the Metropolitan Railway, though I do not know that that method has reached its practical stage yet. However, I feel quite satisfied with this, that my figures show that the distribution of electricity for lighting purposes by thick conductors by the parallel system, by such a system as that which has been proposed is, I am afraid, out of the question, because it is financially impracticable."

I have during the six years that have passed since these words were uttered, neither seen nor heard anything to change my views. On the other hand, everything has tended to confirm them. A movement that looks very like an organized conspiracy to decry electric lighting has been operating through the press of this country to impress upon this high-pressure system the stigma that it is highly dangerous to person. Accidents, the result of hurried construction, careless suspension, personal stupidity, and the absence of proper regulations in New York and other cities in the States, have been so magnified that much fear and diffidence in this system have been established. But in England, where the work done is more substantial, where bare wires suspended on poles along our streets are not allowed; where supervision is organized, and where regulations are extant, there have been, during the past five years, only two fatal accidents; and it is by no means evident that even these were due to the high tension system. (I attach a schedule of the accidents that have occurred in all Europe since 1880.) In London, out of 2,338 fires last year, two only were attributed to the electric wire, while gas is credited with 209.

E. Fesquet—Direct and alternating currents of high tension for lighting and power can safely and successfully be distributed by means of underground cables, provided ordinary precautions known to all electricians are taken. In my own experience I have used 3,000 volts. An installation I put up at Tours in France has a primary alternating current of 2,500 volts, and has been running satisfactorily during four years without accident of any kind. The conductors in this case are underground.

Q. 2. *If your answer to question 1 is in the affirmative, state whether your opinion is based upon theory or upon knowledge of what has actually been done. If the latter, give a full statement of the facts upon which you base your opinion, showing, as far as possible, the extent to which high tension currents, both direct and alternating, have been distributed by means of underground cables in the various cities of the United Kingdom and the Continent; the length of time during which cables now in successful operation have been in use; the voltage of currents thus distributed in various cities, and the approximate number of lights operated in various cities by means of such cables.*

Sir William Thomson—My opinion is primarily based on general knowledge of the insulating power of the materials used for insulating the conductors of submarine cables and electric light systems, and on measurements made in my own laboratory of voltage required to break down insulations of different kinds. A very small thickness of insulation suffices to resist 2,500 volts, and practically moderate thicknesses are not broken down with 5,000 or 6,000 volts, and are very safe with 2,500, whether direct or alternating. There has not hitherto, so far as I know, been very much practical experience of 2,500 volts on underground conductors in electric lighting, but I have great confidence that it can be carried out, whether with direct or alternating currents, successfully and with every promise of durability of the materials.

Professor George Forbes—The opinion expressed above is founded upon experience and knowledge of what has been done, and after paying most special attention to this part of the subject for many years, and after having inspected within the last fourteen months the most important electric light works in Great Britain, the continent of Europe and America.

In London, the London Electric Supply Corporation has had several miles of underground cable working at 2,400 volts (alternating) for several years. These cables are of best quality vulcanized india-rubber, laid in cast-iron pipes.

The Eastbourne Electric Lighting Co. began work eight or nine years ago, with 2,000 volts continuous current supplied by underground conductors. At Hastings, the same action was taken at the same time by an allied company. Three years ago the continuous current at Eastbourne was abandoned, and an alternating current of 2,000 volts was substituted, new underground mains being used. During all this time the condition of the cables has been perfectly satisfactory. In each of these towns the circuits cover some 8 to 10 miles, and there has been no case of fire, nor any loss of life.

Another allied company is the House to House Co. in London, which has a very fine central station, working alternating currents at 2,000 volts, and has several miles of mains. These cables are generally copper covered with jute fibre impregnated with bituminous compound, and covered with lead. They are laid in cast-iron pipes, with frequent man-holes.

At Rome, in January, 1889, there were 17 kilometers of underground mains distributing alternating currents at 2,000 volts. These were stranded concentric cables, insulated with impregnated jute, encased in lead, served with protective compound, armorclad with iron strips, and further protected by an outer serving of tarred hemp. These have been at work for over two years, and at the date mentioned (January, 1889) were supplying 9,000 incandescent lamps of 16 c. p., and 200 arc lamps.

At Milan, in January, 1889, there were some miles of similar cable distributing alternating currents at 2,000 volts, supplying about 1,600 lights of 16 c. p.

At Nancy (France), there were 10,000 lights in April, 1889. These are supplied by alternating currents at 2,400 volts, by means of underground mains, to which connections are made every few yards. The mains consist of stranded concentric cores, insulated and protected by iron wire strand.

At Tours (France), three years ago, the mains for working a 2,000 volt alternating system were replaced by cables insulated with vulcanized india-rubber, to the extent of six or seven miles, which have worked satisfactorily.

High pressure continuous currents have been worked through underground cables at the Silvertown Electric Works for about eight years without any trouble. The insulation is high-class vulcanized india-rubber.

Numerous other cases might be quoted. I mention those which have come under my special observation. In all of these cases the cables have worked satisfactorily. There has been absolute safety, hardly ever any irregularity in the supply and remarkable freedom from fires.

Dr. John Hopkinson—In this country three companies are using the alternating high tension current for lighting purposes on a considerable scale, the Grosvenor Gallery Co., the Metropolitan Electric Supply Co. and the House to House Co. At the present time the major portion of the conductors of the Grosvenor Gallery Co. are overhead. The cables are manufactured by the Silvertown company, and are insulated with india-rubber, and carried on separate bearing wires. From the Grosvenor Gallery station this company work at a potential of 2,400 volts. They have been at work since about 1886. So far as I know, only one death has occurred in connection with this system, and that some time ago. In this case a youth appears to have received a shock from the conductor, and to have fallen through a skylight and been killed by the fall; whether he would have been killed or not by his contact with the conductor is unknown. I understand that the Grosvenor Gallery Co. have for two years had a pair of Silvertown cables insulated in the same way in a pipe under St. James' Park, and that this cable has not given the slightest trouble of any kind. The Grosvenor Gallery Co., or rather their successors, the London Electric Supply Co., are establishing a station at Deptford, for supplying parts of London. From this station it is proposed to supply at a tension of 10,000 volts; but, so far as I am aware, satisfactory working has not yet been attained with so much as 5,000 volts.

The Metropolitan Electric Light Co. have at present two stations on the alternating system, both working at 1,000 volts. From Sardinia street at the present time they are supplying about 500 h. p.; from Rathbone place, about 100 h. p. The cables are almost all laid underground. They are Silvertown india-rubber insulated cables laid in iron pipes, several cables in each pipe. With these cables they have had no trouble of any kind, either in the way of breaking down of insulation or of shocks. The experience of this company appears to show that it is desirable that the iron pipe should be cast in a vertical position, by so doing chaplets may be dispensed with, which if present, tend to leave points within the pipes liable to injure the cable.

A Silvertown cable in an iron pipe has been in existence under a potential of 2,400 volts, underground in St. James' Park for about two years.

The House to House Co. have one station at work in London, from which they have about 16 miles of cables. These cables are also manufactured by the Silvertown company and are laid in iron pipes, in the same manner as are the Metropolitan company's cables. The House to House Co. work at a tension of 2,000 volts. They have at present about 6,000 8-c. p. lamps connected up and 11,000 wired. I understand that their maximum output is about 55 amperes or 110 kilowatts. The House to House Co. have also stations at Eastbourne and Brighton, but their London station is probably the best of the three.

Concerning recent continental practice, I am not prepared to answer from my own knowledge.

W. H. Preece—The currents for the alternating current high pressure system in England are safely and successfully distributed both by means of continuously well insulated and properly suspended overhead cables, and by means of thoroughly well insulated conductors buried underground in pipes. The voltage used is generally from 1,800 to 2,400 volts.

E. Fesquet—My opinion is based on practical experience extending over ten years, during which I have been entirely employed in alternating current work. Since 1885 a central station in London has been distributing light by means of alternating current of 2,400 volts and transformers, by means of conductors which are partly overhead and partly underground, the number of lamps supplied being about 20,000. Other companies have since been working in London and provincial towns, with alternating currents of 2,000 to 2,500 volts. One alternating current plant has a tension of only 1,000 volts.

I put up a station in Germany in 1885 when the alternating current used was 2,500 volts. The conductors were overhead—the number of lamps being about 2,500. This station has worked up to the present time with perfect success and without accident.

I also put up a station in Italy in 1885 when the alternating current used was 2,500 volts—the conductors being overhead—the number of lamps about 500. The working has been regular, successful and without accident.

Q. 3. Give some idea of the character of the cables used and the manner in which they are laid.

Sir William Thomson—A great variety of plans may be used safely and successfully for both direct and alternating currents. One method for alternating currents consists in placing the two conductors as coaxial cylinders, having sufficiently thick space between them filled with insulating material; surrounding the outer conductor with a less thick layer of insulating material, and enclosing the whole in a lead or iron pipe. The conductors for this system may be copper tubes, but it is generally preferable to make them of wire strands laid with a moderate twist on the proper cylindric surfaces. The inner conductor should be of six strands laid spirally as close together as possible, on a hempen or other non-metallic core. Each wire should be prevented from metallic contact with its neighbors by slight insulation. This method gives practically absolute security against danger to the public.

Professor George Forbes—The types of cable which have done such good service for high pressure work, are generally known in the trade by the following names:—

(1) The Silvertown vulcanized india-rubber cables.

(2) The Siemens concentric cables.

A year ago I had occasion to draw attention to serious breakdowns in the lead-covered type of cable in the electric lighting system of Berlin. This system is worked at low pressure, and very large conductors must be used. The outside of the cable is some three inches in diameter, and when coiling this on a four-foot drum, I conceive it to be quite possible that the lead is severely strained, and, becoming punctured, admits water. This is not so much to be feared with the smaller cables used with high-pressure currents.

As to the manner of laying the conductors, the Siemens concentric cables being ironclad, and being generally laid under the footway, do not require any further protection. In crossing streets they are generally run in pipes.

The vulcanized india-rubber cables are laid in wooden boxes, concrete troughs, or iron pipes. The last of these plans is the most generally adopted. Vulcanized rubber can only be used when of the best material. It then cannot be excelled. Its quality for durability may be judged by tests of its insulation resistance.

The lead covered cables are now generally drawn into iron pipes.

The weak part of a cable is at the junctions to the service lines. Special care must be paid to the manner of insulating these joints.

Dr. John Hopkinson—I have already indicated the character of the cables used.

W. H. Preece.—My view is that there is nothing more practical than 4" or 6" cast-iron pipes, laid from one to three feet underground in which thoroughly well-insulated and well-protected copper conductors are drawn. There are several insulating materials in the market capable of insulating 2,000 volts, but my experience is chiefly with india-rubber. I see no difficulty whatever in maintaining a pressure of 2,000 volts in underground conduits. It has already been done for eight years in Eastbourne.

N. B.—For 4½ years, 2,000 volts continuous current (Brush) were used.

E. Fesquet—The conducting cables used in England, France, Germany and Italy, by me, have been india-rubber covered cables, not concentric—the latter being laid parallel to prevent induction. When cables are laid underground, I use a cast-iron pipe or wooden trough filled with bitumen, the cable being supported by bridges.

Q. 4. What is your opinion as to the safety to the consumer and the public at large, of the converter or transformer system of electric lighting, involving the use of high-tension alternating currents in the street mains?

Sir William Thomson—With properly laid mains the high-tension alternating currents in the street mains underground, involve I believe no danger whatever, to the public at large. The converter or transformer system can, I believe, be made absolutely safe to the consumers by proper arrangements. It has already been largely practiced in London, Glasgow and elsewhere; and as far as I know, no instance has occurred of any consumer having met with an accident.

Professor George Forbes—Previous to 1885, when a low pressure system alone was available, engineers were in search of some high pressure system which would reduce the copper required to a reasonable amount. Their attempts were mainly in the direction of a parallel series system. But they could not recommend it, because of the danger from defective insulation in the house wiring causing high pressure shocks to the consumers. After the alternating current transformer system had been proved to be efficient, it was accepted as the required solution of the difficulty, because the house wiring is, on this system, completely separated from the street mains. Every one in this country who then came to this conclusion, and has had experience of the system, has been confirmed in his belief that the transformer secured the required safety.

Dr. J. Hopkinson—There is in my opinion no reason whatever why high tension alternating currents should not be used in the street mains.

W. H. **Preece**—I have advised the Metropolitan Electric Supply Co., of London, to adopt the same system, and they are doing so, and I have also advised several local authorities in England to do the same thing, and they are going to do it.

I do not express my opinion lightly on this subject. There are about 30,000 miles of underground insulated wire of the United Kingdom under my control, and I have had 37 years' experience of such wires. I venture to think that this experience is unique in its continuity and extent.

E. **Fesquet**—The converter or transformer system involving the use of high tension alternating currents, can be used with absolute safety to the consumer and the public at large. No accident can happen if well-known precautions are taken, and the neglect of them implies great ignorance.

Q. 5. What is your opinion as to the relative fire danger in the transformer or converter system and in the low tension direct current system, respectively?

Sir William Thomson—In the event of the escape of gas, in the neighborhood of the high tension mains, the high tension alternating current may set it on fire; but probably not so the low tension direct current. Within a house or building in which the electric light is used, the danger of fire is not materially different in the two cases, and in either it may be practically annulled by proper arrangements. I believe also, that the transformer itself, when properly constructed, and properly mounted and guarded, does not cause any danger of fire.

Professor George Forbes— In a low pressure net-work system of mains, the resistance is very low, so that if a short circuit occurs in any house wiring (or, if the mains leak, a connection of the house wiring to earth suffices), it is quite possible to have 10,000 amperes, or more, going through these house wires, previous to the going of the fuse, even if the fuse is in good working order. This current, even if it lasts only a small fraction of a second, is able to cause fire-risks. With the transformer system this is not at all the case. The possible current is here limited by the size of the transformer; in the direct supply system it is limited only by the possible output of the central station. The transformer system is safer, because the house wiring is detached from street mains. If the street mains have a bad leak, a contact of the house wiring with gas or water pipes may cause a fire on the direct system, but not so on the transformer system. With proper precautions, however, strictly enforced, as in England, to prevent a short-circuiting of the house wiring, and to prevent leakage from the street mains to earth, both systems are absolutely safe.

Dr. John Hopkinson—In my opinion there is practically no difference as regards fire risks between the converter system and the direct current system.

W. H. **Preece**—There is no more danger of fire from the one system than there is from the other. Perhaps the low tension direct system is the more dangerous of the two, for its fancied security leads to relaxed supervision, while there certainly are conditions when an intense low tension current is more dangerous than a 2,000 volt alternate current. It is an anomaly, though a truism, to say that where there is most danger there is the greater safety; and the reverse is equally true. The reason is that where there is danger there are precautions taken; where there is supposed safety, supervision and care cease.

The immunity from accidents on our British railway system, and on our great steam shipping lines is an illustration of what results from careful inspection and proper regulations. A first-class railway compartment on the Midland Railway, or a state saloon on an Atlantic liner, is as safe a position to be placed in as in a drawing-room arm-chair. The system of boiler insurance and supervision in this country has an equally striking and satisfactory result. Boiler explosions are very few and far between.

E. **Fesquet**—The fire danger in a properly arranged transformer or converter system, may be made much less than in the low tension direct current system, the large quantity necessarily carried by the latter being always a source of danger; besides, its main system must always be directly connected with the house service, and no amount of protection fuses can alter the fact.

In a direct current system distributing mains and house circuits being connected, it is difficult to detect the exact spot where a leak may have occurred, but in the transformer system, a leak in the conductors inside the houses of consumers, can never be connected with the distributing main, and the position of a leak in this latter is easily detected.

Q. 6. In your opinion, is the converter or transformer an effectual safeguard to protect the user of electric illumination from danger from shock or fire?

Sir William Thomson—In my opinion, the transformer, when properly made, properly mounted and supplied with proper safeguards, is thoroughly effective to protect the user of electric illumination from danger from shock or fire.

Professor George Forbes—If the transformer has its primary and secondary coils made separately and insulated separately, and if fuses are placed in both primary and secondary circuits, and if the mechanical construction is such that there is no rubbing and wearing of the insulation between primary and secondary coils, then the transformer is an absolute protection to the consumer against fire and life risks. All these requirements can easily be fulfilled. Major Cardew's safety device suffices to render even bad transformers a protection to the consumer.

Dr. John Hopkinson—In my opinion a properly constructed converter with a suitable cut-out is an effectual safeguard to the consumer against danger from shock. As regards fire the precautions must be the same as with the direct current system.

W. H. **Preece**—The safety of a high pressure system is entirely a question of precaution, design and care. If the following rule be carried out:—

> "Alternate current transformers must be supplied with two main fuses, double-pole switch, and an *earthing device* on the secondary circuit, all of which must be securely fixed in a water and fire-proof structure (by preference situated outside the premises) placed under lock and key, and beyond the control of any unauthorized person"—

and the work in a house be thoroughly well done and maintained, I can conceive of no danger to person or to building which can arise. The earthing device is a most efficient and satisfactory safety valve. But if maintenance be neglected, if the cheap Jack and the Jerry builder be admitted, if safety devices are neglected, then the electric system can become as dangerous as gas, and the converter might emulate in insecurity the kitchen boiler or the steam pipe.

E. **Fesquet**—Yes. Under proper conditions.

Q. 7. State to what extent the converter or transformer system is now being used in London and other cities in Europe for lighting from central stations, as compared with the low tension direct current system, and in favor of which of the two systems the present development in electric lighting in Europe seems to be?

Sir William Thomson—The present development of electric lighting in Europe seems to be in favor of the transformer system on the whole, because of the facilities it gives for transmitting the electric energy over great distances with moderate amounts of copper.

Professor George Forbes—The best idea that can be obtained as to the relative use of low pressure direct supply, and high pressure alternating current transformer supply, at the present time, is to be got by analyzing the evidence given before Major Marindin, at the Board of Trade enquiry on the electric lighting of London, in 1889. The following table shows the companies which were given powers for one or other of these two systems, the capital which had been authorized, the amount which had been paid up at the date of the inquiry, and the number of square miles in London allotted to them:—

LOW PRESSURE DIRECT SUPPLY.

	Authorized capital.	Paid-up capital.	Area square miles.
Westminster Electric Supply Corporation	£100,000	£8,000	1.5
Kensington and Knightsbridge Electric Lighting Company	250,000	37,240	1.1
St. James and Pall Mall Electric Light Company	100,000	26,000	0.3
Total	£450,000	£71,240	2.9

HIGH PRESSURE TRANSFORMER SUPPLY.

	Authorized capital.	Paid-up capital.	Area square miles.
London Electric Supply Corporation	£1,250,000	£585,000	5.3
Metropolitan Electric Supply Company	500,000	152,732	3.7
House to House Electric Light Supply Company	350,000	41,600	1.1
Total	£2,100,000	£779,332	10.1

The most certain way of judging of the comparative amount of business being done by the several companies is, to compare the paid-up capital in each case. Here we find that the companies working on the low pressure direct supply system had contributed 8.4 per cent. of the total paid-up capital, while those using the high pressure alternating system had contributed 91.6 per cent. of the total paid-up capital. I should mention the fact that a small area was allotted to a company called the Electricity Supply Corporation, but I can find no evidence in the reports as to what system they are to adopt, nor any facts about their capital. The Notting Hill company, so far as I can learn, is not doing anything. The Chelsea company is a high pressure supply, reduced in pressure by batteries.

The general evidence elsewhere in England and Europe generally is, that at present high pressure is most generally adopted, and almost always on the alternating current system. A very significant fact is that Mr. Crompton, who was a most able advocate of the low pressure system, has lately secured the contract for lighting the town of Chelmsford, and has himself selected the alternating high pressure system with transformers. It is my firm conviction that at present and until a storage battery is found which is cheap, efficient and durable, most of our municipal lighting in Europe, including Great Britain, will be on the alternate current high pressure transformer system, and that only in exceptional cases can a low pressure supply be economically given.

Dr. J. Hopkinson—In addition to the alternating current system stations there are in this country certain direct current installations. In London there are the St. James' Co., the Chelsea Co., and the Kensington Court Co. In the provinces there is Bradford and there are other places. So far as I am able to judge there seems to be a somewhat larger application of the alternating current than of the direct in London. Taking the whole of the country it is difficult to say; it is proposed to apply each in many places.

W. H. Preece—The system of distribution in houses is essentially a low pressure system, whether the energy be derived from alternate current converters, continuous current batteries or low tension central stations. The high pressure and supposititious danger are confined to the external mains and feeders, which, if kept underground, can be made absolutely safe.

E. Fesquet—The present development in Europe. including London, is greatly in favor of the alternating system.

Q. 8. *Explain to what extent high tension currents, direct and alternating, are necessary for the successful and economical distribution of electricity for lighting and power purposes, and state what, in your opinion, would be the effect upon the electric light and power industry, and the interest to the public in general, in case the use of high tension direct and alternating currents were abandoned, and all lighting and power work done exclusively by means of the low tension direct current system?*

Sir William Thomson—The mass of copper required for the economical transmission of electric power to distances of more than a mile is so great, relatively, to the value of the work done, if the potential be limited to 100 or 200 volts that in my opinion it would be fatal to the electric light and power industry, and to the interests of the public in general to abandon the use of much higher potentials than 200 volts.

Professor George Forbes—The reason why electric lighting from central stations made no progress in England till 1885, was only in part due to the Electric Lighting Act. It was mainly due to the fact that electricians saw that the copper required for feeders from a central station, to supply 100,000 lamps on the three-wire low tension system, on the most economical principles, must have a total section of at least 50 square inches each, which is impractical. They resolved to wait until a satisfactory high tension system should be worked out. Of these, the parallel-series system could not be adopted, because the house wiring was in direct connection with high pressure mains. The storage battery system might have been used, if the efficiency, economy and durability of these were sufficient for practical work on a large scale. Even now, the secondary battery has not been sufficiently perfected in these directions. If it were it would be very generally adopted. The transformer system is the only one which has satisfied those engineers here who have had experience, as an economical and safe means of converting high into low pressure. For large towns high pressure is a necessity, especially in America, where the houses which are to be supplied are often at great distances from each other. If high pressure systems were abolished in England electric lighting would, from an engineering point of view, be in the same position as five years ago. Central stations could then be started only in extremely concentrated districts where light is used up to late hours.

Dr. J. Hopkinson—The great advantage of the high tension system is that the generating station may be placed at a considerable distance from the work to be done. In cases where the generating machinery can be put close to the work no doubt the direct system would be adopted. But in large towns this is not unfrequently impossible, not alone upon the ground of capital outlay in real estate, but also on the ground that the powerful machinery required would be an annoyance in the neighborhood. Thus, if high tension currents were prohibited it would involve two things for the public, a much greater cost of supply and the annoyance of machinery placed in a place where it is undesirable.

E. Fesquet—The high tension systems, both with direct and alternating currents, are essential to an economical distribution of light and power—the possibility of using water power at a distance is itself an element in the question which is an obvious advantage; even if steam power is used, it can be done more economically outside a town; then the possibility of concentrating at one point the motive power required for supplying a large district with light is an immense advantage from an economical point of view; it is probably the possibility of establishing central stations, to supply large areas from which may be considered to start the general application of electricity. If all lighting and power work were done exclusively by means of low tension direct current the advantages within the reach of all would be withheld until a wiser generation should arise to take advantage of the facilities offered by the high tension system. By every direct system the consumer can use only one kind of lamp; by means of converters the consumer can select any type of lamp.

Q. 9. *Can high tension, direct and alternating currents be safely distributed by means of overhead conductors? If so, under what circumstances, and by means of what precautions?*

Sir William Thomson—Yes, I believe perfectly and easily, except in cities; and even in cities by the observance of the rules for public safety which have been imposed by the British Board of Trade. For the transmission to great distances over the country I believe electric energy can be conveyed by currents, whether direct or alternating, through a pair of bare copper wires, at a distance of from five inches to a foot from one another, insulated by porcelain or glass insulators, and supported on poles, with perfect safety to the public. The requisite security against the possibility of electric damage to man or beast, through breakage of a wire or blowing down of poles, can, I believe, be made practically perfect by proper appliances.

Dr. John Hopkinson—The experience of the Grosvenor Gallery Co. shows that high tension alternating currents can be safely distributed by means of overhead conductors; this has been attained by the use of thoroughly well insulated conductors carried upon independent bearing wires.

Professor George Forbes—High pressure direct or alternatcurrents can be safely distributed by means of overhead conductors, if proper rules are made, and means arranged for enforcing them. In the last five years the central station at the Grosvenor Gallery in London has supplied by overhead conductors alternating current at 2,400 volts to about 15,000 sixteen candle power lamps, or the equivalent. The contractors foresaw that carelessness on their part might lead to accidents, and so to condemnation of their works. The work was all of the best. Best vulcanized india-rubber insulation braided, was used, and the mechanical construction of the lines was excellent. The cables are all supported by insulating suspenders on a steel wire. The supports are all firmly stayed on the tops of houses. Inspection of these is perfectly easy. There has never been a death from shock, except perhaps one, where, however, the sufferer fell from a house roof, and the cause of death was uncertain. Fires on this system have been almost unknown. The rules for overhead wires, prepared by the Board of Trade, are in my opinion more than sufficient for the protection of the public. Æsthetic considerations prevent us at present from suspending our cables on poles in the streets. In towns where elevated railroads are allowed in the streets, I do not think that this consideration need have much weight.

E. Fesquet—I have put up several overhead conductors for alternating current at high tension. The poles I have used have been generally iron, the insulators of porcelain, the india-rubber covered conducting cable has been sometimes supported by a steel wire. Storms that have wrecked telegraph and telephone wires have left my conductors uninjured, and I have never had any accident from the current during my experience of 10 years.

Q. 10. *Kindly make any other suggestions which occur to you which will bear upon the present discussion in the United States as to the conditions under which electric lighting from central stations can be most safely, successfully and economically done?*

Sir William Thomson—The comparatively small currents required in the mains on the high tension alternate current system give it many advantages over all low tension systems; as, for instance, the smallness of the conductors and consequent ease of laying as well as economy of prime cost; and the security against any current strong enough to do damage underground or elsewhere being allowed at any time to pass through them, through any accidental short-circuiting at crossings.

Professor George Forbes—I have been in the United States this year, and seen the condition in which New York City is at present. This would all have been prevented if the electric lighting companies had looked to permanent rather than temporary profits; if the Board of Electrical Control had been composed of able and unbiased electric engineers; or if the civic authorities had not lost their heads. It has been a foolish thing to insist on putting the wires all underground, if the public have a right to expect the most for their money. The cost of electric light will be thus increased fully 50 per cent. What ought to be done is to register every electric light wire, and subject it to strict regulations, such as those issued by the English Board of Trade, under the advice of the Institution of Electrical Engineers. Of course it is only high pressure mains which could be carried overhead for light and power purposes. Low pressure ones would be too large.

If panic legislation were to stop the use of high pressure currents of electricity the public would be largely deprived of a great boon. I must qualify my remarks by saying that in Broadway and many other business parts of New York, where large numbers of telephone wires must of necessity be allowed to occupy the air space, it may be necessary to compel electric light wires to be put underground.

To prevent my remarks in Answer 3 from being the cause of mistakes, I wish to state that in using vulcanized rubber cables the joints must be vulcanized by experienced men.

DR. J. HOPKINSON—In my own practice I am guided in the choice of high or low tension entirely by the consideration of where the generating plant is to be placed. If it can be conveniently placed in the immediate neighborhood of the whole of the work to be done, I adopt the direct system of supply at low tension; if this is not the case, however, I advise the adoption of high tension alternating currents.

W. H. PREECE—It is an absurdity to argue that because alternate currents of high pressure will cause death that therefore electric lighting by alternate currents is dangerous. You might as well argue that it is dangerous to eat food with a knife because a man cut his throat in a fit of jealousy; or that it is dangerous to light a fire because a child burnt its finger by picking up a live coal. Danger depends much more upon the personal element than on that of principle. Accidents in all spheres are generally due to carelessness, recklessness or ignorance. More people are killed by blowing out gas than by electric currents, and there are more people killed by the traffic in the streets of London every week than in the whole of the United States by electricity every year.

Safety (certainly with electricity) is easily purchased by exact design, efficient material, experienced workmanship, proper supervision and careful maintenance, and this can be acquired by high tension alternate currents as readily and as well as by any other form of electrical energy.

E. FESQUET—I consider that substantial, safe and reliable work can be done at prices which will enable a good profit.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Course of Subway Litigation.—Confirming the Constitutionality of Electrical Execution.—The Edison-Gilliland Phonograph Suit.—Utilizing Niagara Electrically.—The Woman's Exchange Exhibition.

THE fight during the past month for the control of the new electric light subways, cannot be said to have had decisive results, and yet matters have been definitely advanced. Judge Andrews in the Supreme Court has denied the motion of the persistent and persevering Manhattan company for an injunction restraining the Board of Electrical Control from making a contract with the Standard Electrical Subway Co. He holds that such a contract would be legal and would inflict no injury. In the meantime, a stay of proceedings has been obtained. The probability is, that no matter what the arrangements may be, finally, New York will see more subway building this year than ever.

The Court of Appeals at Albany, has affirmed the judgments in the courts below in the Kemmler case, and has declared the electrical execution act to be constitutional. The Court was unanimous. It refuses to do so behind the action or opinion of the legislature in passing the law, as a humane advance, and says: "Whether or not electricity is more humane, was a question for the legislature alone to determine, and they had more chance of so determining than an appellate court." The amusing part of the situation is the manner in which some of the newspapers are now making elaborate preparations for violating the new law, which, it will be remembered, forbids the reporting of executions.

Judge Wallace heard arguments recently in the United States Circuit Court, on the demurrer to the complaint in the suit of Thomas A. Edison against John T. Tomlinson and Ezra T. Gilliland. Mr. Tomlinson was the personal attorney and Mr. Gilliland the confidential assistant of Mr. Edison. Mr. Gilliland had an agency contract with the inventor in connection with the phonograph, and Mr. Tomlinson had charge of the negotiations which resulted in the sale of all of the Edison patents on the phonograph to the Lippincott company organized to make and sell the machines. The defendants received $250,000 in the stock of the company, but Mr. Edison says that he understood that the stock was of little value, whereas the defendants had a contract with the phonograph company under which they were to receive the par value of the stock, so that it is stated, they made $250,000 while the inventor received $500,000. W. Bourke Cockran argued the case for the defendants, and Eaton & Lewis for the complainants. Judge Wallace said that they might hand briefs to him, and he reserved his decision.

The fourth annual report of the commissioners of the Niagara Falls Park, has been submitted to the legislature. The commissioners have located the line for the proposed electric railway from the falls to Queenstown, and will ask a legislative grant of $25,000 for its construction. The commissioners say that the proposition made by some Americans to lease the water power of the Canadian falls for the purpose of getting electricity for transmission to cities and towns as a motive power and for lighting purposes has fallen through. Proposals have, however, since been made on behalf of an English syndicate for the same privileges, and negotiations have just been closed and a deposit of $10,000 made with the commissioners to bind the contract. Whatever these proposals may be, there seems no doubt that the great hydraulic tunnel scheme, a work well within the resources of ordinary engineering, will be carried out in the very near future.

It will be of great interest to electricians to learn that one of the principal attractions of the exhibition of the Woman's Exchange at the Lenox Lyceum, which will be opened on April 7, will be a loan exhibition by Mr. Edison of the inventions shown by him at the Paris Exposition. The extent of these may be understood from the fact that 232 cases have been shipped directly from Paris to the Lenox Lyceum, where their contents are now being placed in position. It was originally intended that the Edison inventions should be shown at the World's Fair, in New York, but as that opportunity of making the American public acquainted with the examples of Mr. Edison's inventive genius is not likely to be afforded, it occurred to the directorate of the Woman's Exchange that the forthcoming display at the Lenox Lyceum would be admirably supplemented by what can justly be regarded as the most remarkable collection of apparatus and devices of its kind that has ever been brought together; and when Mr. Edison was applied to he not only gave his immediate consent to the arrangement, but contributed $5,000 as a donation to the Woman's Exchange. The preparations for the six-weeks' course of entertainment are most elaborate, and include a programme of popular amusements the like of which has seldom been enjoyed in this city.

Professor H. J. Ryan, of Cornell, and a party of "electricals" have been making a tour of inspection through the electrical stations, factories, etc., of this part of the country.

NEW YORK, March 27, 1890.

PHILADELPHIA.

Subway Fighting.—The Lehigh Avenue Storage Cars.—Lighting for Oak Lane.—Western Union Testing its Right to Run Wires on Poles.—Conshohocken First Mortgage Bonds.—The McLaughlin Electric Company.—An Electric Road for Lititz.

THERE will be a lively fight in city councils the present month over the ordinance granting the American Subway Electric Co. the right to lay its conduits in certain streets. It will be a fight between the Edison and Westinghouse companies, and it looks as if the latter would win if it will only use the same tactics that were employed by the Penn Electric Co. to get its ordinance through councils. All the work is underground, and it is hard to convince councilmen that these conduits are necessary. The Penn Electric was badly milked before its ordinance went through, and it looks as if the "boys" intend repeating the operation with the subway. The officers of the American Subway Electric Co. declare that they already have enough contracts with the Westinghouse Electric Light Co. to warrant the building of a concrete conduit over the many miles of streets for which they have made application. Although the conduit will nominally be open to the public it will practically be controlled by the Westinghouse people. The latter declare that they would not build a conduit if they would be allowed to run their wires through the Penn Electric conduits. The latter are controlled by the Edison Electric Light Co., which refused to allow the Westinghouse wires in their conduits, so it is alleged, and this forced the last named company to arrange for an independent conduit. As the Edison company will practically have a monopoly of incandescent lighting in the business portion of the city if the subway ordinance can be defeated it will make a vigorous fight against the measure.

A large number of prominent men, including members of both branches of councils, the directors of public works and safety, members of the bar and large capitalists, visited Germantown Junction recently, at the invitation of the Lehigh Avenue Railway Co. The company proposes to run a line of electric cars on Lehigh avenue, and an invitation was extended to ride on and examine these cars. An elaborate collation was served at the depot at 23d street, after which the machinery of the car was explained by Mr. J. Wharton, who is president of the company. The car is run by means of two motors and a storage battery of 92 cells, which are situated under the seats—42 on each side. The car weighs 12,000 pounds, and can run at a speed of 14 miles an hour, although in the regular use it will be run at six miles an hour.

Oak Lane, a suburb of Philadelphia, is to have an electric light plant before the lapse of many months. There will be a 10-mile circuit that will take in Shoemakertown, Ogontz, Jenkintown and Oak Lane. It is stated that $15,000 worth of stock has already been subscribed for. Over 3,000 incandescent lights have been introduced into private residences. The venture is almost an assured success already.

John R. Read, Silas W. Pettit, George H. Pearson and Wager Swayne, counsel for the Western Union Telegraph Co., have filed a bill in equity in the U. S. Circuit Court against the City of Philadelphia. The bill is brought to test the right of the company to string its wires on poles without the consent of the city.

The Conshohocken Electric Light and Power Co. has decided to issue first mortgage six per cent. bonds to the amount of $20,000, for the purpose of wiping out the concern's floating debt and extending the plant. The Norristown Title, Trust and Safe Deposit Co. has been selected to act as trustee in the mortgage for the bondholders, and to register the bonds.

The McLaughlin Electric Co. filed articles in the Camden county court recently for an increase of capital from $300,000 to $1,000,000. Senator John J. Macfarlane is president of the company, which claims to own a storage battery that will run a street car 80 miles an hour.

The citizens of Lititz have appointed a committee to confer with General Manager Pugh, of the Pennsylvania Railroad, about the construction of an electric railway from Lancaster to Lititz. The cost of the road would be $100,000.

PHILADELPHIA, March 25, 1890.

BOSTON.

Tests of Safety Cut-Outs.—Mr. Dustin Killecutt's New Appointment.—The Wirt System of Car Lighting.—The Russell Arc Lamp.—Col. Hewins on Storage Cars.—Capt. Griffin on Electric Railways.—Peripatetic Cornell Students.—The American Bell Annual Report.—Lighting Public Buildings.—Tests of the Interior Conduit.—W. J. Denver on Telephone Troubles.

Elaborate tests are still being made by Messrs. Brophy and Killecutt, of the Boston Fire Underwriters' Union, on various safety cut out devices for the protection of low-tension small current wires, should they come in contact with high-tension or heavy current wires.

Mr. Dustin Killecutt, for about five years connected with the Boston Fire Underwriters' Union, has resigned his position, and will hereafter represent the Simplex Electrical Co. in New England. Mr. Killecutt's wide experience of the necessities of good work in varying circumstances, and his contact with all the electrical men of New England, should make him a valuable assistant to Dr. Mason, the popular representative of the Simplex company.

THE Russell Electric Lamp Co. has been organized for the manufacture and sale of the Russell arc lamp, one of which is on exhibition at 85 Water street, Boston. The upper carbon is in the form of a disc, about 4½ inches in diameter, while the lower carbon is of the ordinary pencil form, about 14 inches long. With one set of carbons, the lamp will burn 18 to 24 hours, consuming 16 inches of carbon. The disc carbon is rotated by means of a small ratchet operated by a toothed rod, which in turn is operated by the electro-magnets in the case above.

A new system of lighting electric street cars using the overhead or conduit system, has just been patented by Mr. H. C. Wirt, a gentleman who has become widely known as one of the patentees of the K. W. cut-out. At present, when the trolley accidentally comes off the trolley wire, or at the end of a journey when the trolley is reversed, the car is left in darkness. Mr. Wirt's patent is designed to obviate this difficulty. He uses six small accumulator cells, in series with the motor, and the lamps of 12 volts are in multiple with the accumulators. The battery is connected in such a way that the current used in the motor, would charge the battery when no lights are used. When the lights are burning, the current does not pass through the battery, the lights being supplied direct from the line. When the trolley comes off or is taken off the trolley wire, the battery supplies the lamps.

Colonel E. H. Hewins, of the Union Electric Car Co., gave an interesting lecture before the Society of Arts, at the Institute of Technology, his subject being "The Application of the Storage Battery to Street Car Propulsion." The lecture was profusely illustrated by stereopticon views, and by power diagrams, which attracted considerable attention. Mr. Hewins is a firm believer in the storage battery, and brought a large amount of actual experience and close observation to bear on his subject.

Captain Eugene Griffin, gave an interesting talk on electric railways to the members of the Harvard Electric Club this week. He made special mention of the new feature of subdividing the vast net-work of trolley wires into small sections, so that any possible defect in one section would not interfere with the cars on other sections.

Professor E. L. Nichols, of Cornell University, accompanied by a number of his students, has been making a trip through New England for the purpose of inspecting the progress in electrical affairs. While in this city they visited the West End power stations on Albany street and at Allston, the Thomson-Houston factories at Lynn, and made an evening visit to the chief station of the Boston Electric Light Co.

The American Bell Telephone Co. report for 1889, published at length this week, was a grand one. The net earnings for the year were equal to about 26¾ per cent. on the old capital, and rising 21 per cent. upon the enlarged capital. Of the new capital $1,250,000 shared in the dividend of Jan. 15, 1890, and was made a charge against 1889 earnings. The remaining half will participate in the July dividend. The report shows that the telephone business of the country is steadily increasing, that the number of "exchanges," as well as the number of subscribers, is materially greater than a year ago, that the wire mileage is growing rapidly, and that the so-called "long-distance company" is rapidly pushing its work into new fields. In every respect the business of the company seems to be prosperous, and with the exception of the "government suit," which the directors do not seem to have thought worthy of mention, there is no threatening of any consequence.

A committee of three of the board of aldermen, has been appointed to consider the subject of lighting the city hall, old court house, and the registry of deeds building, by establishing an electric plant in the basement of the city hall, to obtain estimates of the cost, and report the same to the city council together with such recommendations as they may deem advisable.

A most interesting and elaborate series of tests of the interior electrical conduit, was made in the Tremont theatre building this week, before the fire underwriters, and the representative architects and builders of Boston. The tests were conducted by Mr. E. H. Johnson, president of the Interior Electrical Conduit Co., assisted by Mr. W. A. Willard, treasurer; Mr. H. M. Underwood, general sales agent; Mr. E. T. Greenfield, electrical construction superintendent, and Mr. George DuBois, general superintendent of construction. A test was made by overheating two rubber covered wires run in ordinary wooden moulding, which had the effect of charring the wood, and in ordinary circumstances might set fire to a building. The same test was then made with wires in the conduit, without any signs of damage to the conduit.

Tests were made of heavy short-circuits, which showed the impossibility of doing any damage to the surrounding property when the wires were enclosed in the conduit. Mr. Johnson showed specimens of the new form of conduit, which is perfectly fire-proof, the whole tube being dipped in an enamel solution which gives it a fire-proof coating. Twin wires are recommended for branches, with very light insulation between, though there may be a rubber insulation over the two. This prevents any possibility of a prolonged arc, which might not blow the fuses, and enforces a quick short circuit, in times of weakness, when the safety fuse will immediately melt. Mr. Johnson afterwards drew attention to a model of the underground system, and explained it in detail. The tests were quite successful and made a marked and favorable impression on the audience.

At a meeting of the Boston Electric Club, an interesting paper by Mr. W. J. Denver, of the New England Telephone and Telegraph Co., was read and discussed. The subject of the paper was "Induction and Interference with Telephone Service from a Telephonic Point." Mr. Denver traced the history of the telephone business and its early trials both by leakage and induction. The first troubles came with the advent of the electric light. All sorts of experiments have been tried to eliminate induction, but up to the present, Mr. Denver claimed that no satisfactory preventive had been invented. He described in detail elaborate tests which were made on the Cambridge division, with the McCluer system, but stated frankly that no improvement had accrued. Other anti-induction devices were tried but all proved failures. Mr. Denver then went on to explain the troubles which had arisen from the electric railways, which use the ground for a return, and quoted widely from papers read by Mr. Preece, Dr. Louis Bell, and Mr. Nelson W. Perry. Mr. Denver, in summing up, stated that the best way to avoid induction was to use a twisted copper metallic circuit, and a balance should be maintained between the two sides of the circuit. Other improvements also should be adopted. Low-tension wires and high-tension wires should be separated from each other as much as possible. In electric light circuits he recommended the transposing of the wires occasionally, and the balancing of the two sides as nearly as possible. In conclusion he said: "I do not know that it is necessary to dwell upon what might be done with grounded wires carrying a high-tension current, except to say that there are good reasons why there should not be any such circuits." The paper was afterwards warmly discussed by Dr. A. F. Mason, Mr. H. F. Campbell, Mr. John C. Wilson, Mr. Alex. P. Wright, Mr. A. C. Shaw, and Mr. George Cutter, of Chicago.

BOSTON, March 25, 1890.

CHICAGO.

City Lighting Operations.—Interference of Lighting and Telephone Service.—Arc Lamp Litigation.—Generating Current by Water Power at Portland, Ore.—Chicago and the World's Fair.—Sewing Carpet Lengths with a C. & C. Motor.—Train Lighting by Carpenter Storage Battery.—The Chicago Electric Club's Library.

ONE hundred and fifty arc lamps on the north side, Chicago, are now supplied with current from the city's new station on Chi.

cago avenue. At present there are in operation eight Thomson-Houston 35-light arc machines. The four automatic high speed engines of 150 h. p. each were made by A. L. Ide & Son. It is intended to increase the capacity from time to time, as appropriations are made by the City Council until 1,000 lights are supplied with current from this plant. The station was so constructed that it will accommodate dynamos sufficient to supply that number of lamps. The circuits are all underground. The 25 miles of cable are of the Standard, Patterson and Cobb types.

The new city station on Throop street on the west side has been finished. The electrical apparatus in the old station on Jefferson street is to be removed to the Throop street power house, and in all 20 Western Electric dynamos will be operated there. This will be the largest municipal electric light station in the city. Prof. Barrett said recently that he could use to advantage $750,000 next year in extending the municipal electric light system.

The Chicago Telephone Company recently notified the city electrician that its service on the north side has been very seriously interfered with since the power house on the north side had begun operations. It attributed its troubles to induction from the city electric light circuits. The telephone lines are overhead and the city circuits underground.

It is predicted that as a result of Judge Gresham's decision, which construed the Brush double carbon arc lamp patent so broadly, considerable litigation may be expected. Actions have been instituted by the Brush Electric Company against the Sperry Electric Company of Chicago, and the Electric Lighting Company of Belvidere, Ill. The latter company uses Sperry apparatus. The Brush company has also begun a suit against the Columbus electric lighting company. In all these actions infringement of the Brush patent is alleged and an issuance of an injunction is asked for.

The Western Electric Company, of Chicago, has brought a suit against the Sperry Electric Company, of Chicago, charging the defendant company with infringing its patent No. 420,109 granted to Charles E. Scribner for a single carbon arc lamp. The patent, although applied for seven years ago, was not issued until January last.

A. J. Coffee, city electrician of Portland, Ore., is a firm believer in the practicability of utilizing the power of Niagara. He cites in support of his faith in the project the success which has attended the use of the Oregon River Falls, twelve miles from Portland, for the generation of electricity. He was recently in Chicago, and in speaking of this matter said: "All the lights in Portland are operated by current generated by the Oregon City Falls. Not only this but the power for electric railways, elevators and small manufactories is obtained from the same source. If this is feasible and profitable there can be no question as to the plan of harnessing Niagara Falls."

Chicago thinks with great confidence that it will manage in its own city the next World's Fair. If by any legislation a change should be made in the programme the Western metropolis would feel as if it had been shabbily treated. Chicago electrical workers are already considering what it becomes them to do to prepare for the great exposition. In fact, a day or two ago, a Chicago inventor informed the correspondent of THE ELECTRICAL ENGINEER that he had already devised a plan for illuminating the fountains during the international fair. It is assumed that now that the fight for the site is over all electricians will join heartily in a movement to make the electrical exhibit the most significant feature of the fair. That the electrical department can be made by all odds the most interesting section can not be doubted. The only thing to fear is a lack of timely action. Electrical workers are so busily engaged that it is hard for them to spare the time to consider what is to be done two years, or more, hence. There is no possibility that there will not be exhibits enough; it is only a question of quality. It is hoped, therefore, that this matter of presenting a display of electrical apparatus, which will represent the best work of American electricians, will be generally borne in mind so that there may be a striking demonstration of the fact that America leads the world in practical electrical invention and application.

An interesting application of an electric motor has recently been made in the wholesale dry goods house of Marshall Field & Co., Chicago. A C. & C. ¼ h. p. motor operates a traveling sewing machine which, as it moves along, sews together the edges of two lengths of carpet. The machine is mounted on bicycle wheels which, as the rubber tires have been removed, fit snugly into a track on the floor. The current is taken from a trolley wire which is supplied from the central station of the firm. The practical advantage of using the apparatus may be realized when it is stated that two machines operated by six boys can sew as many lengths of carpet in a day as 300 girls. Up to the present time it has been found impracticable, it is stated, to sew any of the heavier grades of carpet except by hand.

One of the chair cars on one of the Union Pacific trains is lighted by current from the Carpenter storage batteries made in Denver. The coach has been inspected with considerable interest by a number of experts in Chicago.

The Chicago Electric Club expects to have one of the most complete electrical libraries in the country. Arrangements have been completed by which the books owned by the old American Electrical Society of Chicago will be secured by the club and the library committee proposes to add to this nucleus every standard electrical book published.

CHICAGO, March 25, 1890.

ST. LOUIS.

The Municipal Company's Work.—Electric Railway Extension.—Use of the "Short" Double Trolley Parallel System.—The Citizens' Electric Light Company.

THE Board of Public Improvements are urging the Municipal Electric Light and Power Co. to complete arrangements for a trial of the Jenney low tension and Wood high tension lamps. The Municipal company are making preparations for such test to take place on Delmar avenue, under the direction of the Supervisor of City lighting, who has, by the direction of the Board of Public Improvements, prescribed a rather crucial ordeal extending over a period of some ten nights. Meanwhile the Municipal company are adjusting Wood arc lamps in preparation for fulfilling their contract with the city and are making every effort to complete their plant ready for lighting the city by April 15th. The bill granting the Municipal Electric Light and Power Co. an extension of time for 105 days from January 1st after passing the Council a month ago is still in the hands of a committee of the House of Delegates.

The New American Electric Arc Light Co. of New York threaten suit against the Municipal Electric Light and Power Co. for using the new Wood apparatus, claiming that the new Wood apparatus are infringements on patents which they acquired of the American Electric Manufacturing Co. by receiver's sale. The Municipal Co. claim to have ample guarantee as to such matters from the vendors of the "improved" Wood apparatus.

The mayor has signed the bill authorizing the Lindell Railway Co. to equip with overhead electric power their two Forest Park extensions and main lines except the down-town portion. The new bill authorizing them to equip their down-town lines has been placed before the municipal assembly. Some seventy Sprague motor cars will be put into use during the coming summer.

The Benton Bellfountain Railway have introduced a bill before the municipal assembly asking for the privilege of equipping their road with overhead electric power through the down-town district. They already have a franchise that authorizes them to equip the outer portion of their road with electric power.

The Short series electric railroad on the south end of the St. Louis Railroad line is being converted into a double trolley parallel system. All the mechanical difficulties of the overhead switches have been eradicated.

The Cross-Town Electric Railway was incorporated on the 17th. Capital stock $100,009, half paid up. Stockholders C. C. Carroll, G. W. Brown, P. P. Manion, Given Campbell, D. K. Ferguson and E. D. Meier, purpose to construct an electric railway across town approximately along the line of Eighteenth street.

The South St. Louis R. R. have filed the necessary bond and accepted the franchise which authorizes them to equip their entire road with overhead electric power.

In East St. Louis two factions, the St. Louis and East St. Louis Electric Railway and the Citizens' Electric Railway Co. are striving before the city council for a franchise on the principal streets. The St. Louis and East St. Louis Electric Railway who already have their line in operation across the bridge, appear to be the people's favorite. They have secured the names of some two thousand citizens to their petition. The Citizens' company are not idle and are being backed by a wealthy corporation—the Wiggins Ferry Co. The Belleville Street Railway Co. also ask for a franchise through the city and to connect with the St. Louis and East St. Louis Electric Railway—Bridge Line.

The Citizens' Electric Light Co. began lighting the City of East St. Louis on March 1st under a three-year contract at $125 per lamp for the first 60 lights and $110 for additional lamps when required.

Two additional motor cars have been added to the equipment of the bridge line—the St. Louis and East St. Louis Electric Railway, making a total of six cars. The increased service being necessitated by increased patronage due entirely to the rapid transit and well warmed cars. The Burton electric heaters have given general satisfaction, although owing to the mildness of the winter they have not passed through a very crucial trial.

The St. Louis R. R.—Broadway line—have decided to adopt cable instead of electric power. This change of heart is due to the fact that it is not possible to get an ordinance authorizing them to erect overhead wires through the central portion of the city. They will, however, give the Short double trolley parallel system a trial on the south end of the road, and will probably extend it to their Seventh street section. A bill is now pending before the municipal assembly asking for the privilege of additional tracks on Broadway and Seventh street south of Elm street; the two tracks on Seventh street are to be used as an electric line while the additional track on Broadway, together with the old track, will be cabled. This change will give them a complete double track on Broadway throughout the entire length of their line and renders their road specially suitable for cable work.

St. Louis, March 25, 1890.

PITTSBURGH.

The Rapid Transit Fever and the Duquesne Traction Company.—Report of the Westinghouse Electric Company.—The New Westinghouse Arc Lamp.—Mr. L. B. Stillwell on Light and Power Distribution.

The rapid transit fever which came over Pittsburgh some time ago has now reached the stage of an epidemic. At every meeting of councils a new corporation springs up asking for the passage of certain ordinances granting it divers privileges to operate a street railway. The evident result will be that within the next five years the Gas City will have a street car line on every thoroughfare. At the last meeting of the City Councils alone, eleven street car ordinance were passed, each one referring to a separate line. These lines comprise, however, one system, which is known as the Duquesne Traction Company. The branches are: The Craig Street railway, the Highland Street railway, the Lorimer Street railway, the Howe Street railway, the East End railway, the Wilkinsburg and East End railway, the Wilkinsburg railway, the Duquesne railway, the Market Street railway, the Ellsworth Street railway, and the Negley Avenue and Roup Street passenger railway company. The ordinance of the Duquesne Traction Company grants it the right to enter upon and use certain streets, lanes and alleys and to lease the property and franchise of certain passenger and street railway companies, or either, and to construct and operate, or either, by means of electricity or otherwise, passenger or street railways or either. The company is granted all the privileges that were ever granted to any other similar corporation in the United States on the following and only condition: "That the company shall within 30 days after the passage of the ordinance file a proper written acceptance of it, binding the company to expend in good faith within two years from date, not less than $12,500 per mile in paving with block stone each and every mile of single track of any of the street railway companies enumerated above, which shall be operated, or upon which motive power shall be supplied by the Duquesne Traction Company." The franchises give the company the largest circuit of any street car company in Western Pennsylvania covering in a direct line a distance of twelve miles. The capital stock of the corporation is estimated at nearly $500,000. From what has been learned, electricity is to be the motive power on the entire Duquesne system and whichever company gets the contract of supplying the motors will certainly get a rich plum. The fares are to be five cents over the entire line.

The Second Avenue electric road, a new line, on which the Thomson-Houston system is used, has begun operations. The cars run from Market street, Pittsburgh, to Glenwood, a distance of four miles. The company was threatened with a suit by the Central District Printing & Telephone Co. of this city, but the trouble is said to have been settled. The Telephone Co. alleged that the induction caused by the close proximity of the electric motor wires to the telephone wires occasioned a buzzing noise in the telephones, which greatly impaired their usefulness.

The Westinghouse Electric Company held a special meeting a few days ago and issued the following statement:

Total sales for the year	$4,362,115.22
Cost of manufacture, including material, labor, manufacturing supplies and all royalties paid	2,242,138.30
Manufacturing profit	2,119,976.92
General expenses (including repairs to factory machinery and tools)	767,087.56
Gross profit	1,362,889.35
Lease and rentals (paid to leased companies)	215,555.94
Extraordinary expenses, patent and legal, experimental, interest and discount	407,525.54
Net profits for the year	729,807.87
Sales for six months ending June 30, 1889	1,492,406.15
Sales for six months ending December 31, 1889	2,896,709.07
Total sales for year	4,362,115.22

It will be noticed that the sales of the second half of the year are nearly twice as large as for the first half, which is due to the fact that the leased companies were not in full operation until July 1.

On the evening of March 16, the new Westinghouse arc light system was for the first time introduced upon the streets of Pittsburgh. A large number of the prominent city officials and the representatives of the press were invited. Everything was favorably commented upon by the observers, the steady light of the lamps and the flat carbon feature receiving most of the complimentary remarks.

At the last meeting of the Western Pennsylvania Engineer Society, Mr. L. B. Stillwell, one of the electricians of the Westinghouse Electric Company read an interesting paper on the distribution of light and power by electricity. Among other things he stated that statistics compiled by the secretary of the National Electric Light Association in 1889 showed that there were then in use in this country 237,017 arc lights, 2,704,768 incandescent lights and 109 street railways operated by electricity, covering 579 miles of railway. These represented a capital of $275,000,000 and an engine capacity equal to 500,000 h. p.

Pittsburgh, March 25, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

W. AND DEWEY'S CATALOGUING SYSTEM.

[120.]—It was not my intention to present arguments in my brief note about Dewey's treatment of engineering. My purpose was only to present facts in so lively and vigorous a manner as to call attention to the matter; it appears with some success. If there is any argument, it was accidental, or at most, incidental to this purpose. If there was any indignation, it was only an induction effect from some neighboring circuit; the subject was not the original source of any such energy.

It is not very apparent what the opinion of the surveyors, etc., in the rural districts, whom W. has known, about their titles has to do with the subject; nor that his familiarity with these people has been of great benefit to him in considering it. Commercial importance of a species would be no reason for a philosophic scientist to elevate such species into a genus. But would not the merchant who should arrange his warehouse, inventories, etc., according to a botanical or zoological philosophical system of genera and species, instead of according to commercial importance, convenience of use and customers, etc., be regarded as a pedantic dilettante?

This leads to the only important point in close connection with the subject that I find in W.'s remarks.—Is a system of cataloguing a library a philosophical scheme of human knowledge, for the satisfaction of the logical faculty, or is it a tool, a directory, a means to the easiest, quickest, largest, best use of the contents of a warehouse? W. appears to assume that it should be the former. If it should be so decided, and the requirements of the two should differ at some points, which should prevail? After these fundamental questions, the specific question, whether Mr. Dewey has successfully met the requirements of either, concerning engineering, remains.

W. argues against the differentiation of electrical and mechanical engineering because "a plant may run for months without derangement of its electrical parts," "Its installation is almost entirely mechanical," and "the purely electrical details are so definitely settled beforehand by the laboratory expert or inventor." Who is this inventor, and the laboratory expert? And who is the man that can find the cause of the electrical derangements, when they do occur, and remedy them, and who can intelligently assure the most efficient use of the plant, and the best modifications of it to suit any new conditions or requirements that may arise? W. seems to consider the electrical engineer, "as distinguished from the engineer," as the man who "takes hold" of just what is set down for him and runs it, as long as it is not deranged. This is like calling a stoker, who starts and stops and runs an engine and some machinery, while it is not deranged, a mechanical engineer, but calling the man who can design engines or determine a whole mechanical plant for any purpose a *laboratory expert*, not an engineer.

For the invention and for the designing of electrical machinery, for the designing of electrical plants to meet all conditions and purposes, for the intelligent and efficient management of these, an amount of study of, and familiarity with, a specialty of great extent and difficulty, electricity, is required which makes a large and fundamental differential for electrical engineering. But what large and important subject differentiates the *Roofs-and-Bridges Engineer*, for instance, from the Mechanical Engineer; or the *River-Harbor-and-General-Hydraulic Engineer* from the *Canal Engineer?*

I submit that the treatment of engineering in Mr. Dewey's system does not meet the logical requirements of a philosophical classification, which W. assumes to be the proper test; nor is it, as terms are now used and understood, the best formed tool, directory, or aid to the use of a library.

I. THORNTON OSMOND.

State College, Pa., March 15, 1890.

SOCIETY AND CLUB NEWS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meetings of the council of the Institute on February 7 and March 18, the following gentlemen were admitted to associate membership :—

Donald B. Heilman, Jonestown, Pa.

Clarence J. Spike, Halifax, N. S.

W. G. Whitmore, electrical engineer, United Edison Manufacturing Co., 65 5th avenue, New York city.

Alfred S. Brown, electrical engineer, Western Union Telegraph Co., 195 Broadway, New York city.

Arthur J. Newell, electrical engineer, R. T. Oakes & Co., Holyoke, Mass.

Michael I. Pupin, instructor in mathematical physics, Columbia College, 68 W. 72d street, New York city.

Arthur E. Nichols, student in electrical engineering, Columbia College, 16 E. 35th street, New York city.

William Elmer, Jr., under-graduate in electrical engineering, Princeton University, Princeton, N. J.

Edward G. Waters, electrical engineer, Thomson-Houston Electric Co., Boston, Mass.

Chas. Steinmetz, electrician, Osterheld & Eickemeyer, Yonkers, N. Y.

Richard Varley, Jr., electrician, Okonite Insulated Wire Co., Passaic, N. J.

William H. Freedman, honorary fellow in electrical engineering, Columbia College, 120 W. 125th street, New York city.

Philip S. Malcom, western agent, Gibson Electric Co., Portland, O.

Charles Henry Davis, consulting electrical engineer, 120 Broadway, New York city.

John M. Fox, electrician, Edison United Manufacturing Co., 133 W. 34th street, New York city.

George G. Grower, electrician and chemist, Ansonia Brass and Copper Co., Ansonia, Conn.

John C. Lee, chemist and electrician, American Bell Telephone Co., Longwood, Brookline, Mass,

William B. Halsey, inspector of lines and instruments of messenger department, Postal Telegraph Cable Co., 94 Leonard street, New York city.

J. C. Bennett, electrician, United Edison Manufacturing Co., 65 5th avenue.

Caryl D. Haskins, electrician, Thomson-Houston Electric Co., Lynn, Mass.

A. J. Lawson, electrical engineer and contractor, Montreal, Canada.

Captain Eugene Griffin, Thomson-Houston Electric Co., 620 Atlantic avenue, Boston Mass.

Edward C. Davidson, of Baldwin, Davidson & Wight, patent lawyers, Times building, New York.

Cary T. Hutchinson, Sprague Electric Railway and Motor Co., 16 Broad street, New York.

Robert Lundell, designing draftsman, Sprague Electric Railway and Motor Co., New York.

Charles L. Cornell, electrical engineer, Western Engineering Co., Kearney, Neb.

Bert Buys, electrician, Rutherford, Boiling Spring and Carlstadt Electric Co., Rutherford, N. J.

Charles N. Black, Princeton, N. J.

A. H. Bauer, electrical engineer, Pullman's Palace Car Co., Chicago, Ill.

Charles F. Uebelacker, Princeton, N. J.

Elmer Z. Burns, consulting electrical engineer, 120 Broadway, New York.

Wm. H. Stadelman, vice-president and chief engineer, Equitable Electric Railway Construction Co., Philadelphia, Pa.

The following gentlemen, already associate members, were upon their application, and the recommendation of the board of examiners, transferred to full membership :—

F. A. Pickernell, superintendent of equipment, American Telephone and Telegraph Co., New York city.

Wm. E. Shepard, electrician, Schuyler Electric Light Co., Middletown, Conn.

Wm. W. Griscom, president, Electro Dynamic Co., of Philadelphia, managing electrician of the Electrical Accumulator Co., New York city.

Gilbert Wilkes, assistant to naval inspector of electric lighting, Navy department, Washington, D. C.

Professor John E. Davies, professor of physics, University of Wisconsin, Madison, Wis.

H. Doijer, assistant in physics, laboratory work, Delft, Holland.

William J. Hancock, superintendent of telephones, department of public works, Perth, Western Australia.

Horace F. Parshall, assistant electrician, Sprague Electric Railway and Motor Co., 16 Broad street, New York city,

Hammond Vinton Hayes, electrician, the American Bell Telephone Co., Boston, Mass.

Frankland Jannus, solicitor of patents, Washington.

Franz Schulze-Berge, assistant to Thomas A. Edison, West Orange.

Wilson S. Howell, central station electrical expert, Edison Electric Light Co., New Brunswick, N. J.

NEW YORK ELECTRICAL SOCIETY.

A visit of inspection was paid by the New York Electrical Society on March 26, to the Equitable Building, upon invitation of the Westinghouse Electric Company. About 150 members and their friends availed themselves of the excellent opportunity thus presented of seeing an alternating current incandescent plant in full operation. The exhibit included the generating plant driven by a Westinghouse compound engine, banks of converters, single converters, the beautiful Shallenberger meters up to the 80-light size, demagnetizing coil, cigar lighter, Tesla motors, stage regulator, lamps, switches and all the other details. Much interest was shown, and innumerable questions were answered by Messrs. Noble, Hubbard. W. Wheeler and others who represented the Westinghouse, United States and Sawyer-Man Companies.

At the last meeting of the Society the following members were elected :

Caryl D. Haskins, Thomson-Houston Electric Co., Lynn, Mass.
A. D. Doman, 36 Union square, New York city.
Richard Varley, Okonite Co., 13 Park row, New York city.
John James, Jr., 64 Madison avenue, New York city.
Chester D. U. Hobbie, Box 722, Yonkers, N. Y.
Chas. H. Kinyon, 84 Warburton avenue, Yonkers, N. Y.

NEW YORK ELECTRIC CLUB.

On Tuesday, March 18, the annual meeting of the club, to nominate officers for the year beginning May 1, was held, and the following gentlemen were nominated. The election takes place April 17, 1890: *President*, O. E. Madden; *vice-presidents*, Grosvenor P. Lowrey, General E. S. Greeley, Erastus Wiman, W. D. Sargent; *secretary*, Charles W. Price; *treasurer*, Willard L. Candee; *board of managers*, J. C. Chamberlain, H. L. Storke, A. H. Patterson, S. Insull, J. J. Carty, J. A. Seely, J. H. Herrick, C. E. Stump, C. H. Barney, H. D. Stanley, Cyrus O. Baker, Jr., Geo. B. Coggeshall, W. J. Morrison; *committee on membership*, Henry Hine, F. Z. Maguire, George T. Manson, George Worthington, Lieutenant F. W. Toppan, U. S. N.

LITERATURE.

The Alternate Current Transformer in Theory and Practice. Vol. I. By J. A. Fleming, M. A., D. Sc. London,, 1889. The Electrician Publishing Co. 487 pp. 8vo. Price, $3.00.

THE construction of alternating current machinery for use on a large scale in electric lighting, has made it necessary that electrical engineers should study far more deeply than they have ever done before the laws of mutual and self-induction, of periodic motion, etc., which, from the fact that they had played so small a part in the practical applications of electricity, had been passed over with only the most superficial study. The student learned that a current when started in a wire induced a momentary current in a neighboring wire forming part of a closed circuit, and that a momentary current in the opposite direction was induced when the current in the first wire was stopped. He knew the effect of approaching a magnet to a coil, of moving two coils to or from each other. He had learned to ascribe these effects to the cutting of "lines of magnetic force" by the conductor, and had learned to compute the E. M. F. developed by a given rate of cutting. He knew that it took time to start a current in a coil of wire and that a current once started could not be instantaneously stopped. But how many appreciated the fact, so familiar now, that a coil in the path of a rapidly alternating current would act as a resistance to greatly reduce the current while consuming very little energy? How many understood that the secondary of an induction coil could be made to give any desired multiple of the E. M. F. of the primary, either higher or lower?

The use of alternating currents for electric lighting necessitated the discussion of such problems as these, and there was a demand for works giving a detailed treatment of the whole subject such as had not before been attempted. Dr. Fleming has come to the front with a work that will be welcomed by every student who has had his attention directed to alternating current phenomena, and by every electrical engineer who has to deal with alternating current apparatus.

In the introductory chapter, Dr. Fleming gives an interesting account of Faraday's original experiments and discoveries in current induction, and shows how Faraday at that time pictured to himself the lines of magnetic force that have played so important a part in the later study of magnetic theory.

The second chapter treats of the laws of electro-magnetic induction. The relation of the strength of induced magnetization to the strength of the magnetizing field is fully discussed, but it is rather strange that the author should not have defined the coefficient μ at the outset, as the ratio of the strength of magnetic induction to the strength of field, instead of treating the total induction as the sum of the lines due to the induction in air and those emanating from the magnetic poles developed on a magnetic body. The idea that iron is more *permeable* than air and that, therefore, a magnetic field develops more lines of force through it, seems so very simple that the coefficient μ would seem to need no other definition than that indicated above, namely, that it is the ratio of the strength of magnetic induction to the strength of field.

Further on the phenomena of current induction are described and the laws fully developed. The self-induction of a circuit is well treated and the coefficient L well defined. The curves of magnetization given in this chapter will be found very valuable, and every engineer who has to do with the designing of dynamos, will find the treatment of hysteresis full of interest. This part of the chapter might be made still more valuable by the addition of data giving the energy dissipated for different degrees of magnetization. The writer has found that much less energy is wasted in the core of an armature when a given E. M. F. is developed by high speed in a weak field than when the same E. M. F. is obtained by a slow speed in a strong field.

Chapter iii. deals with periodic currents and begins with a very clear treatment of the general subject of harmonic motion. Students who have labored over simple harmonic motions in their college courses and wondered what it was all about and what good it could ever be to any one, must make up their minds to master the subject if they would follow Dr. Fleming. They will find use also for the calculus which possibly they did not "elect". The experimental measurement of alternating currents is a most important subject, and here Dr. Fleming has given us a very full discussion of the effects of periodicity upon the indications of the various instruments usually employed.

Chapter iv. begins with an extended account of the experiments of Professor Henry upon current induction. It is gratifying to find in an English book this recognition of the value of Professor Henry's researches. The engineer and the student of theoretical science will find this chapter upon mutual and self-induction, covering more than 150 pages, a most valuable contribution to the literature of the subject. Space forbids any detailed account of the various topics treated in this chapter. The peculiarities of periodic currents are fully considered, including the greater proportional flow through the outer layers of the conductor, the effects of hysteresis in iron cores, the action of "choking coils," and numerous other topics are well discussed.

The fifth and last chapter deals with the dynamical theory of current induction. Here Dr. Fleming endeavors to develop a mechanical analogy to electric and electro-magnetic phenomena and to show, if not what electricity is, at least what it is like. We have been wont to consider the conductor as the seat of the activities manifested by an electric current, although we have known all along that effects were produced in space all around the conductor. Faraday demonstrated long ago that the nature of the dielectric had much to do with the electric forces manifested. Maxwell analyzed Faraday's results and developed the theory of electric displacement in the dielectric. Then, in order to explain electro-magnetic phenomena, he described a mechanical model which fixed the attention upon the action taking place in space outside the conductor. Professor Lodge in a recent work and Dr. Fleming in the work under review, have both in their own ways developed this mechanical conception, and we are led to see that a perfect conductor, so far from being a seat of activity, may be the only portion of space where no action takes place at all. Practical engineers may look upon such speculations as of little consequence, but it is certainly a fact that anything that helps us to a conception of the ultimate basis of electric action helps us to work more intelligently in devising electrical machinery or appliances.

Maxwell's electro-magnetic theory of light is very well treated, and the results of Hertz's experiments on electric oscillations are very fully given. Indeed, Dr. Fleming has laid the electrical fraternity under great obligations by bringing together in such readable form the very latest results and conceptions of the most successful workers in the electrical field. No work that has yet appeared can do so much to enlighten the electrical student upon the modern developments in electrical science. No other can do so much to guide the student out of the old beaten track into the new ways where fresh fruits are to be gathered.

The second volume will be impatiently awaited by every one who has read the first.

.... I SHOULD be glad if it were generally proclaimed that the elementary training in all our science laboratories should be a training in the art of measurement.—*Fleeming Jenkin.*

.... WE do not know whether any molecular motion is concerned in the manifestation of energy which we call electrical.—*Professor John Trowbridge.*

NEWS AND NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

MEETING OF MARCH 18, 1890.

In the discussion which followed the reading of Dr. Duncan's paper on "Some Tests of Alternate Current Apparatus,"—**MR. NIKOLA TESLA** remarked that Dr. Duncan had brought forward some facts which have not been recognized before; for instance, the fact that the loss in the iron of the converter remains perfectly constant with varying loads, and which he thought ought to be so. In converters in which the primary and secondary are put in the closest possible relation, the increase of the primary and secondary is in an almost constant ratio, and since the loss in the iron is due to something like a difference in action of both currents he thought the loss of the iron ought to be constant within certain limits. With regard to the excessive loss in the dynamo machines in the armature, that Dr. Duncan had found, most of this loss is not due to the fact that we must have that loss, but because we must sacrifice a certain amount for the regulation of the machine. Now, the same machine that Dr. Duncan had tested could be given a greater output and with a loss in the armature of no more than 1 or 2 h. p. But we must work with a highly saturated field in order to obtain a constant potential on the converters. On the other hand, the comparison between the single circuit alternating current and the direct current machine was just, and in the proportion that Dr. Duncan found. On the other hand, if we operated an alternating machine with two circuits, then the output of the machine will no longer be inferior to the direct current machine, but it will be equal to it, if not greater. Now, as regards the general results obtained by Dr. Duncan, he was firmly convinced of their correctness, of course, but also firmly believed that Dr. Duncan had not had the best converter in hand. For he had himself made tests with others of latest make in which the efficiency of such converters was shown to be much higher than is shown by Dr. Duncan. With the improvements made lately he believed that the new converters have now reached a much higher efficiency.

MR. H. WARD LEONARD referred to the theoretical discussion which had taken place in Chicago a few years ago as to the relative merits of the continous and alternating current systems, in which the former had been shown to have a total efficiency of 84.7 per cent., while the latter had been placed at 74 per cent., whereas in his paper Dr. Duncan found it to be only 61 per cent. Mr. Leonard said that the point which was perhaps the most pertinent and which had been pretty well emphasized of late was the fact that the average load of a system of lighting generally through a city is such a very small percentage of the connected devices. He knew of one instance where the lighting had not reached the condition which it will later, as regards supplying a much larger connected load than it has at present, and yet the average load for twenty-four hours was only about 12 per cent. of the connected load. This, of course, brought into very forcible action the efficiency of devices which were low in efficiency under conditions of light load.

DR. S. S. WHEELER referred to a curious case of interaction between two circuits carrying alternating currents, the effect of which was to cause "pumping," that is, aperiodic brightening and dimming of the lamps. These wires were about three miles long and parallel, and after a very extensive investigation it was found that the "pumping" of the lights was due to the alternations on two circuits being nearly, but not quite, synchronous; so that when one set of waves caught up with the set of waves on the next wire while passing them, they first drove those waves ahead and then drove them back. This caused the energy of one circuit to first pile up the energy in the other circuit, and then force it down, and thus cause a pumping effect on the lights. That was overcome entirely by placing the wires in pairs properly. That is to say, the two legs of each circuit had not been arranged side by side; one or two of the circuits had been misplaced. But by bringing those together, so that the negative side or leg of one circuit was right along side of the other leg of its own circuit and not mixed up with the wires of any other circuit, the induction was completely neutralized, and that left the lights perfectly steady.

MR. TESLA, in referring to the point mentioned by Dr. Duncan, viz., how the construction of the converters would be modified when their size is increased, remarked that it was evident that it would be impracticable to increase the size of the converter in the same proportion as its capacity is increased, because as we operate the converters at a constant number of periods we would render a long magnetic circuit transformer very inefficient. A plan was proposed by the speaker a year or so ago to introduce a system in the construction of converters so that all would have the same length of magnetic circuit, no matter whether the converters were large or small. He believed that this would be the proper way of constructing all converters on one system, and that the present method of constructing converters was not right, for every different capacity of converter had a different length of magnetic circuit, and we knew well if one converter is adapted to, say, sixteen thousand reversals, another one with a different length of magnetic circuit is not adapted to the same number of reversals. A year ago they had begun to make all converters of the same length of magnetic circuit so as to render them equally adaptable for the same number of alternations, no matter what their capacity was, so that if, for instance, a converter was wanted that had ten times the capacity of a small twenty-light converter they would practically put in one converter so many multiple circuits as are required to get the capacity desired. Mr. Tesla thought that the results obtained by Dr. Duncan referred to an apparatus which had been in use for some considerable time, but the advances that had been made in that line during the last year alone had been so enormous that one would not recognize this plant at all. Thus the converters at present can be made to have less than half the leakage that they had previously. In other words, it meant practically that a converter could be run with a double load, and likewise the machines had been increased to very nearly double their original capacity.

DR. DUNCAN thought Mr. Tesla's idea of keeping the same length of the magnetic circuit hardly proper. He had worked out the design of a number of converters, and thought that the same period should be retained in the circuit, and the converter should be designed which would give the maximum possible efficiency. For a converter of given capacity one must have a definite period. There is a definite period which, with the given proportions of iron and copper, corresponds with the given capacity of converter; but if we simply increase the cross section of the iron without increasing the length of the circuit we keep the same cross section of copper, which is not a good practice. We have to change both the copper and iron, and he did not think it would be very interesting to design a large number of converters for any given output. As for the efficiency of the plant which was tested, the plant was sent on in November and was supposed to be the latest plant which was produced by the Westinghouse company. He had since heard that the efficiency of the converters had been greatly increased. The losses in the converters could undoubtedly be greatly decreased, especially for larger sizes. As to the relative efficiency of the two plants, it was to be remembered that he had simply taken a 750-light plant, and one dynamo was supposed to be always connected with the circuit in a station of ordinary capacity, that is, of more than twice 750 lamps. We would certainly have the advantage of having at least two dynamos, one of which could be disconnected when the load had reached its minimum, and the efficiency, therefore, would be greatly increased; and also in comparing the efficiency of alternating and continuous plants, we must remember that the business that is catered to by these two plants is very different; that the load diagram of the alternating plant is very different from the load diagram of the continuous current plant. There was a great discrepancy between the curves and the figures of the two. An alternating plant takes up the cream of the business, so to speak. It takes up business in which they get the maximum output for a given number of lamps wired, and in that way we must not calculate the efficiency of the alternating and continuous current plants in order to compare them. If so we are favoring the continuous plant very much. If one can put into a continuous current station an alternating plant which will get business that will pay, it is undoubtedly proper to put that plant in. In the same way, if there is an alternating plant and it is so situated that it can run more economically with a continuous current plant, a continuous current plant ought to be put in. But as the business stood at present a combination of the two plants was undoubtedly theoretically the most efficient.

MR. TESLA, in reply to Dr. Duncan, stated that he proposed not to keep the length the same and vary the section, but simply to vary the section of the copper, at the same time varying the section of the iron. They had plates, for instance, which contain so many multiple circuits. These plates were so made that the coils could be just as well put in as one single circuit transformer, a form of construction invented by Mr. Albert Schmid, of the Westinghouse Co., and in this way they had practically a number of independent transformers, and the only diminution of the capacity of such transformers is that they had a somewhat smaller surface. We might then allow a little higher capacity for that diminished surface.

MR. FREDERICK DARLINGTON drew attention to the fact that one system uses the 50-volt lamp and the other system is forced to use a 100 or 110-volt lamp, and that by the same skill in construction of lamps and the same advance in the art of manufacturing lamps, the 50-volt lamps represent about 20 per cent. more efficiency than the 100-volt lamps. He also stated that they were manufacturing for a considerable time a converter that gave a leakage of .12 ampere on every 40-light converter, and that they had recently, since certain analyses had been made of the iron and the quality and the method of annealing of it had been improved, succeeded in reducing that leakage from .12 to .7 ampere. He also remarked that they were getting out of the total amount of lamps wired on a circuit of the United States Illuminating Co., of New York, 5.8 hours per lamp, which is about 23 per cent. All those points, if taken into account, would, he thought, make the efficiency of the alternating current come much higher than would appear at first thought.

DR. DUNCAN, in reply to Lieutenant John Millis, stated that in England the rate of alternation is determined very greatly by the size of the unit in which the distribution is made. For large units a low rate was commonly employed. It would be found that in most of the continental and English systems the rate of alternations had been decreased as the size of the converter was increased. For a large converter a comparatively low rate should be used, and, as in this country, small converters had generally been employed, the rate was very much greater than if the converter had been large.

DR. MICHAEL I. PUPIN inquired of Dr. Duncan whether he knew of any experiments that had been made lately for the purpose of finding out how much of the lost energy was due to eddy currents and how much to magnetic hysteresis.

DR. DUNCAN remarked that he was not prepared to give any figure on that, because he was experimenting on it at the present time. He was working now to weed out the eddy currents and to determine the effect of hysteresis for different periods of reversal. There were no data at present to tell whether the loss on the iron is due to viscous or static hysteresis. If the change in magnetic force were made at a very low speed then hysteresis due to time would not come in at all; if, at the present speed, it would come in,

MR. LEONARD, referring to his previous remarks, stated that he had been brought to select, in the instance noted, the most exceptional one he knew of as being the future condition of supply of all kinds. In New York City, which, of course, was the most exceptional in the other direction, the Edison station here had instead of five, nearer eight hours average load, which, however, may be somewhat due to the advantages derived from the sale of motive power.

MR. JUSTUS B. ENTZ pointed out that the losses due to eddy currents and hysteresis could be determined by employing different thicknesses of discs and testing in each case.

MR. TESLA stated that the results brought out by Dr. Duncan strengthened him in the idea which he always had, that ultimately the whole loss in the iron would resolve itself into the loss due to the eddy currents. The loss in the iron is constant at all loads; on the other hand, Dr. Duncan finds that the loss is proportioned to the square of the electromotive force, which would be precisely the case if the loss in the iron were due to eddy currents. He thought that an argument for this view.

DR. DUNCAN thought that as for distinguishing between the hysteresis and eddy currents with different thicknesses of plate, unfortunately Ewing had found that, as far as the time hysteresis is concerned, it depended on the thickness of the plate independent of the eddy current, so that it would be impossible to distinguish it in the way suggested by Mr. Entz.

ELECTRICITY AT THE BROOKLYN INSTITUTE.

On the evening of March 21, a meeting was held at the Brooklyn Institute, No. 200 Washington street, in which a Department of Electricity was organized. About 100 members are already enrolled and many residents of Brooklyn and New York, who are connected with electrical work or who are specially interested in electricity, have signified their intention to become members of the Department and of the Institute.

The Department will conduct systematic courses of lectures, accompanied by experimental demonstrations on electricity and its various applications in the arts and sciences; it will provide a laboratory, equipped with instruments of precision for electrical measurements and with other apparatus necessary for the study of electric and magnetic phenomena, that will be open to the members of the Department for experiment and research; it will hold regular meetings for the presentation and discussion of electrical questions; and in general it will furnish those means for the advancement of knowledge in electricity that are provided by similar societies in other cities.

Arrangements have already been made with Professor Robert Spice to give the first systematic course of lectures before the Department on the subject of "Electrical Measurements." The lectures will be very fully illustrated, and will be given on Saturday evenings, beginning March 29th.

At the meeting for organization on the 21st March, Professor Samuel Sheldon delivered a lecture on "The Relative Values of Different Electric Batteries." The lecture was fully illustrated.

All persons who are specially interested in electricity are invited to become members of the Department.

.... SOME may think that an electrician is a narrow specialist. I can only invite such persons to engage in the study of "What is electricity."—*Professor John Trowbridge.*

.... THERE is no teaching more practical, more immediately fertile in results, than that which can be given by the man of science in his laboratory.—*Fleeming Jenkin.*

.... FEW things in physical science appear to me more certain than that what has so long been called electricity is a form, or rather a mode of manifestation of the ether.—*Oliver J. Lodge.*

COLLEGE NOTES.

Massachussetts Institute of Technology.

The new Engineering Building on Trinity Place is completed and now occupied by the mechanical and civil engineers. The structure is six stories high and occupies a space on the ground 148x52 feet. The building is a good example of modern mill construction, though because of its peculiar uses the floor beams and supporting columns are made very massive, much more so than in ordinary factory construction. No attempt has been made at architectural display, but great care has been exercised that the structure should meet its required ends. The ground floor is occupied by the laboratory of mechanical engineering, which is undoubtedly the most complete of its kind. A part of the equipment is composed of a 150 h. p. triple expansion engine, built expressly for the Institute by E. P. Allis & Co., of Milwaukee, Wis. The engine is of the Reynolds-Corliss type with cylinders 9, 16 and 24 inches in diameter and 30 inches stroke; its construction is such that it can be run either single, compound or triple, and with all possible combination of cylinders. This is the first large triple expansion engine ever arranged expressly for experimental purposes, and will allow much work to be done in this laboratory in following out the work begun by Hirn and Hallauer upon simple engines as extended to the triple expansion engine. The steam from this engine and also for the 15 h. p. Harris-Corliss and small Kendall engines, as well as that used for heating the building, is brought underground by a 6-inch pipe from the boilers in the basement of the Rogers building, a distance of about 1,000 feet.

The Harris-Corliss engine is used exclusively for engine tests, and the Kendall for instruction in valve-setting.

A pit contains the necessary tanks, condensers and scales for use in the engine tests. Steam and centrifugal pumps are also provided for testing. A full complement of friction brakes and power scales are provided.

At the front of the building is the applied mechanics laboratory, containing a machine for testing full-sized beams for deflection under given loads and breaking weight, a machine for testing cordage, a machine for testing the deflection of parallel rods and one for studying the twisting of shafts in motion. On the floor above are the offices of the mechanical department and a second room devoted to applied mechanics containing an Olsen testing machine, a machine for testing cements and one for studying the effect of repeated bending upon the elasticity of iron and steel. On this floor there is also an Otto gas engine, a collection of calorimeters of various forms, apparatus for testing injectors and a collection of cotton machinery.

The work in hydraulics is to be much developed, and to this end a wrought-iron tank five feet in diameter and 27 feet high has been provided. The tank connects with a stand-pipe extending to the top of the building, making an available head of about 85 feet. Apparatus will be provided for testing the flow through orifices, over wiers and through pipes, and all the various experiments that can be performed with a moderate quantity of water.

The drawing rooms of the mechanical department, of which there are two, each 96 feet long, together with recitation rooms, occupy the third and fourth stories. The fifth and sixth stories are occupied by the civil engineering department with its drawing and recitation rooms and library.

On the first floor is situated the fan for ventilating the building. It is driven by an independent engine. The heating and ventilating system of the building was designed by Mr. Woodbridge, of the Institute.

The building is to be lighted by incandescent lamps, and for this purpose a dynamo of 500 lights capacity is to be used. The machine is from the United States Electric Lighting Co. Provision is made for an increase of the lighting plant.

The following are the various subjects taken as graduating theses by the fourth year electricals: Messrs. Smith, Blood and Swanton, "A Study of the Efficiency of Alternating Current Transformers by the Calorimetric and Electrometer Methods;" Chas. A. Neave, "Experiments upon Induction Coils for Telephone Purposes;" Carlisle and Clark, "On the Effect of Projecting Teeth in Armatures;" Dunbar and Southworth, "Electrical Methods of Testing Electric Motors;" Baker and Sturtevant, "Tests on Storage Batteries;" Brown and Greenlaw, "On the Leakage of Lines of Force about Dynamos;" La Soeur, "On the Electrolyses of the Halved Salts of the Alkalies;" Mann, "Measurements on Block Signals;" Hall and Raymond, "Tests on a Thomson-Houston Arc Dynamo;" Rice, "A Study of Commercial Current Meters;" Hayes, "A Study of the Effects of Various Strength of Core in Magnetic Telephones."

The Department has received from Mr. L. Prang the gift of a Siemens alternating current dynamo and its exciter of the type used at Mr. Prang's establishment for several years past in connection with the Jablochkoff candle.

The fourth-year electricals are receiving a course of lectures on telegraph engineering from Mr. Jacques of the American Bell Telephone Co.

Mr. H. C. Spaulding, of the Thomson-Houston company, lectured before the Technology Electric Club, March 14, upon electric motors.

Mr. Puffer is giving the fourth-year electricals a practical course in the testing of electric motors by purely electrical methods.

A DINNER TO MYRON D. LAW.

The many friends, professional and others, of Myron D. Law, for nine years the able and popular superintendent of the Brush Electric Light Co., of Philadelphia, gave him a pleasant surprise on Saturday evening last in the shape of a banquet at the Colonnade Hotel, and the presentation of a well-signed letter of regret. When the dinner party came together shortly after 8 P. M., the following gentlemen were present: Myron D. Law, F. A. Lee, J. C. Sager, F. W. Whiting, H. A. Cleverly, J. E. Pentz, W. E. Mellor, C. W. Spear, W. A. Porter. A. J. DeCamp, W. K. Fox, W. A. Drysdale, M.D., C. E. Stump, Wm. McDevitt, L. H. Spellier, F. W. Griffin, H. B. Cutter, A. Shearer, J. E. Shaw, W. S. Griffith, W. D. Marks, D. R. Walker, F. R. Colvin. Letters of regret were read from C. W. Price and W. H. Temple, of New York, and others who could not be present. As to the dinner, the committee spared no pains to make it worthy of the occasion, and the toasts were unusually whole-souled and hearty. The first toast, to the guest of the evening, was, "What is better than good Law? Without it we have confusion; with it all runs smoothly, and system takes the place of disorder. May our guest be a good law unto himself. Parting is pain, but our good wishes attend him. May his new field be a happy one to him, happy to many more whose happiness depends on him." This was responded to by Mr. H. B. Cutter, who formally presented Mr. Law with a handsomely embossed letter of regret signed individually by the entire party. Mr. Cutter fittingly expressed the universal regret at parting with so talented an electrician and so genial a gentleman as the guest of the evening, and wished him God-speed.

After the response to the toast "THE ELECTRICAL ENGINEER," by Mr. F. R. Colvin, Mr. DeCamp was called on and feelingly expressed himself in regard to his loss of one who had worked with him so intimately for the last nine years. At the close of Mr. DeCamp's remarks, he presented Mr. Law with a handsome non-magnetic gold watch from the officers and directors of the Brush Electric Light Co., of Philadelphia. The remaining toasts were responded to by Chief Walker, of the Electrical Bureau of Philadelphia, F. A. Lee, Professor W. D. Marks, Willian McDevitt, C. W. Spear, F. W. Griffin and C. E. Stump. Mr. H. A. Cleverly, though not down on the programme for a speech, was coerced into an impromptu effort that was timely and well received.

At the end of the speech-making, Mr. Law was introduced as "Mr. Myron D. Law, of Denver, Colorado," which introduction was followed by handshaking and a last farewell all around.

MECHANICAL ACTION OF VARIABLE CURRENTS.

M. Borgmann describes in a recent number of the *Comptes Rendus* a research on the mechanical action of variable currents, which forms an interesting extension of the experiments of Professor Elihu Thomson. Lycopodium powder was spread over the surface of a thin layer of mercury lying in a trough placed above a solenoid, through which an intermittent or alternating current was passed. The frequency used was about 300 per second. The powder was found to be set in motion so as to show the existence of two circular mercury currents flowing in opposite directions, and uniting so as to form a diametral current. The effect was improved by making the layer of mercury as thin as possible. Alternating currents gave better results than intermittent ones, and the presence of an iron core within the solenoid much increased the disturbances. It was not found necessary for the mercury layer to entirely cover the top of the solenoid, as the mercury currents could be observed in isolated drops. By placing pieces of metal over the solenoid the mercury currents were changed, and very curious results were obtained by using a ring formed of three equal sectors of copper, brass and zinc. These interesting experiments are capable of a great deal of extension, and M. Borgmann is continuing the research.

GLOBULAR LIGHTNING AT PONTEVEDRA.

D. Ernesto Caballero, professor of physics, and director of the electric lighting manufactory in Pontevedra, recently wrote to the authorities of the Madrid Observatory, giving details of a remarkable meteorological phenomenon which appeared at 9.15 P. M., on January 2d. In a clear sky there appeared suddenly a ball of fire of the apparent size of an orange, which, after falling upon the conducting wires stretched across the city, entered the manufactory, struck the apparatus for distributing the light, from which (after raising the armature of a magnetic circuit closer) it struck the dynamo at work. It rebounded twice from the dynamo to the conductor, and from the conductor to the dynamo, then fell and burst with a sharp detonation without leaving any trace of its existence. Outside the building, and at the moment of falling upon the conducting wires, the ball was seen by (among others) the professor of natural history, Señor Garcéran, and from various effects observed on the wires during the following day there were undoubted manifestations of its electrical origin.

BRUSH'S CLASS OF '69.

The following suggestive little item is from the *Detroit Free Press* of recent date :

A couple of years ago I attended the semi-centennial of Michigan University. There was a large attendance of Alumni and the usual number of class re-unions. Photographers did a lively business in taking groups and among those thus preserved was the class of '69. This class had developed a number of prominent men—ministers, judges, lawyers, teachers, editors, some successful men of business, and several good fellows whose talents had not enabled them to get along very well in the world. Conversing with one of this class upon the mutations of fortune which the race of nearly twenty years had made in a fine group of students, all supposedly on an equality as regarded their running powers, he said: "I will let you into a secret. You observe there in our group Charles F. Brush, the inventor of the Brush electric light. Although we have one or two famous members, he is altogether the most famed as well as the richest man in our class. In college we looked down upon him; we would scarcely acknowledge that he was one of us. Why? Oh, he took the scientific course and we were in the literary department. The literary fellows were the dictators of college life, and set themselves up on a self-supposed eminence that dwarfed all other departments. Not because we had any more talent or worked any harder than the rest, but because it was the notion that a liberal education was a book education, which transcended everything in the way of education and made a marked man of the student happy enough to select the literary course. Ask any of us to-day of our class and the answer is certain to be 'I belong to the Class of '69—Brush's class.'"

WORDS OF GOOD CHEER AND FELLOWSHIP.

To remodel the eminently respectable but slow, easy-going ELECTRICAL ENGINEER, to change it into an enterprising, wide-awake weekly, able to hold its own in a field in which the sharpest competition will be felt, is a task of no mean proportions, amounting, as it does, practically, to the establishment of a new paper. Still the new weekly has many advantages. Messrs. Martin and Wetzler are accomplished newspaper men and genial gentlemen, and their ability and popularity will be supplemented by a liberal policy on the part of the new management. Mr. Phelps is a gentleman of great personal popularity, and he enjoys a wide acquaintance in the electrical field. His newspaper experience has been in the right direction to enable him wisely to manage the affairs of the new weekly. THE ELECTRICAL ENGINEER has our heartiest wishes for its entire success.—*Western Electrician.*

MR. T. C. MARTIN AND JOSEPH WETZLER, former editors of the *Electrical World*, of this city, have severed their connection with that journal, and will hereafter be connected with THE ELECTRICAL ENGINEER, the well-known monthly electrical journal of this city. The ENGINEER will be published as a weekly. The *Review* congratulates the ENGINEER on securing the services of these capable and enterprising electrical journalists, and extends its best wishes for the success of the weekly under its new auspices. Mr. Geo M. Phelps, whose intelligent work as editor of THE ELECTRICAL ENGINEER has been recognized by all, will remain with the ENGINEER as before.—*N. Y. Electrical Review.*

From and after April 1, prox., THE ELECTRICAL ENGINEER, hitherto published in New York as a monthly magazine, will be printed and forwarded to its patrons as "a weekly review of theoretical and applied electricity." As one of the oldest of its class in the American field of electrical science, this periodical has achieved a marked reputation, and in its pages all those who are interested in electrical development may expect to find a safe advocate, exponent and authority, as well as a faithful record of all data and practical accomplishment. The increase in its frequency of publication should also greatly tend to enlarge its circulation and capacity for usefulness, and no doubt this will be the case. The more often that an intelligent journalist can gain the attention of his readers, the more likely is he to enlarge their sphere of understanding and convince them of weighty truths. In these days, when improvement closely follows upon improvement—when new ideas and fresh devices are constantly being evolved—when scientific and mechanical discoveries are daily startling the world—the monthly is too slow a vehicle of intelligence, especially when freighted with electricity. Therefore THE ELECTRICAL ENGINEER does wisely in increasing its usefulness four-fold. The management of THE ELECTRICAL ENGINEER will be vested in Messrs. Geo. M. Phelps, T. Commerford Martin and Joseph Wetzler. Messrs. Martin and Wetzler will have editorial charge of its columns, and bring to their work the necessary energy and journalistic skill to ensure its success as a trustworthy authority in all matters of electrical phenomena and experience. In all respects we anticipate for the paper the kind consideration which it will doubtless deserve. Its office is at 150 Broadway, New York.—*Chicago Journal of Commerce.*

Instances are very rare indeed where the unassuming work of the average newspaper man receives public recognition. When, however, such recognition comes, and it comes spontaneously, it is particularly gratifying. These observations are intended to apply especially to the new departure of our esteemed co-laborers, Messrs. T. Commerford Martin, Joseph Wetzler, Frank R. Colvin and A. C. Shaw, than whom as journalists none are more deservedly popular with the electrical fraternity, and from what we hear they are the recipients of abundant evidence of this fact. We look forward with pleasurable anticipations to the forthcoming issue of THE ELECTRICAL ENGINEER as a weekly under the administration of these gentlemen and that of Mr. George M. Phelps, who continues his interest and identification with it.—*Modern Light and Heat.*

THE NEW YORK SENATE ELECTRICAL INVESTIGATING COMMITTEE'S REPORT.

The Senate Committee on General Laws reported at Albany on March 27 as follows on the electrical investigation :

"The committee has held all its sittings in New York, where the attendance of experts and representatives of the principal electrical companies could most easily be secured. After its first session the committee saw the necessity of having the assistance of an impartial electrical expert, and were fortunate in securing the services of Francis W. Jones, a well-known electrician, to whom we are indebted for valuable advice and assistance. Representatives of the various electric lighting companies, city officials, prominent experts, and others who might be able to give information regarding the recent deaths in New York were called as witnesses. The depositions of Sir William Thomson, of Glasgow, Scotland, (conceded by the experts who testified to be the foremost electrician of the day) Dr. John Hopkinson, Professor George Forbes and William H. Preece, all of London, England, and eminent electricians, were received. These depositions, together with the testimony of several of the witnesses, gave valuable information as to the electric lighting business in the large cities of England and the continent of Europe and the methods adopted there to prevent accidents.[1]

"It appears that substantially all of the electric lighting from central stations in this state is done under one of the three following system : (1) the low tension continuous system ; (2) the high tension direct current system ; (3) the alternating current converter system, involving the use of 1,000 volts or more in main wires, which is reduced by means of converters to 50 or 100 volts on consumers' wires. There are two dangers from electric currents : First, the danger to property from fire, and second, the danger to life from shock. Difference of opinion exists among experts as to what voltage would cause death or whether there is any difference in the danger to life between alternating and continuous currents. It seems to be conceded, and may be taken as a safe rule, that currents of 250 volts or under, either direct or alternating, are safe.

"It appears that 16 persons have been killed in the city of New York during the past three years from electrical currents, most of them being employés of electric lighting companies. Most, if not all of these deaths were caused by a continuous current used for arc-lighting. As far as the committee could ascertain no accident has been caused by underground conductors. The causes for most of the deaths appear to have been carelessness on the part of the electric companies in using poorly insulated or badly arranged conductors, and in neglecting other precautions required for safety. It appears doubtful if an overhead system of wires carrying high tension currents could be, under any circumstances, maintained in the crowded streets of the city of New York without more or less danger to the public.

"The remedy for these evils, in the opinion of your committee, lies in the speedy burial of all electric light and power conductors in New York city and other cities having a population of 125,000 or more, and the enforcement in all cities and towns where central-station electric lighting is carried on, of such rules and regulations as shall compel the companies to properly construct and maintain their plants and adopt such precautions as are required to insure safety to the public. Whatever doubt there may have been heretofore, regarding the desirability of successfully operating underground conductors, has been removed by the experience of New York city with subways and the testimony taken by your committee, which is uniformly to the effect that currents of high and low tension, direct or alternating, may be distributed by means of underground conductors with entire success without interference with telephone and telegraph services and with safety to the public. In the large cities of Europe, underground conductors are, according to this testimony, universally used for the distribution of electrical energy, and in many European cities underground cables, carrying high-tension currents, have been operated for several years with complete success. In cities and towns of under 125,000 inhabitants, where the streets are less crowded, and where overhead telephone and telegraph wires are less numerous, electric light wires may be operated with safety, provided proper precautions are taken. But even in cities of less than 125,000 inhabitants, we believe the interest of the public would be best served by placing electric light wires in the principal streets underground.

"Testimony, including that of representatives of the New

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[1] See page 176.

York Board of Fire Underwriters, shows that the fire risk in connection with electric lighting is no greater than in the use of gas, if as great. The testimony shows that both the high and low-tension systems can be made equally safe to life and property by the use of proper safety devices.

"The testimony of experts is to the effect that the converter system involving the use of the high-tension alternating current in street mains, affords a system which is, if properly guarded, free from danger to either life or property. It is, therefore, the opinion of your committee that it would be unwise and unjust to the public to restrict by legislation, the danger from high-tension currents used in lighting being admitted; the wires carrying them should be kept out of reach of the public, as should street wires under the converter system. Considering the testimony taken, we do not think it possible for the legislature to form satisfactory rules and regulations for application to an industry which is not only highly technical, but constantly developing and presenting new conditions, rendering the rules proper this year possibly obsolete next year. There should, however, be some form of supervision by properly qualified state or local authorities over the commercial use of electricity analogous to the supervision now exercised over steam boilers. Regulations should be framed with competent expert advice and entrusted to authorities who have power to modify them so as to meet the changing conditions which the rapid growth of the industry constantly brings about.

"As already indicated, there are two questions upon which the legislature might properly act, by providing: First, that no electric-light or power current of over 250 volts pressure be allowed to enter any building; second, that after, say January 1, 1892, no overhead conductors carrying currents for lighting or power purposes be allowed in any street, highway or public place in any city of the state having a population of 125,000 persons or over, and that the local authorities in the various cities coming under this description, in the absence of any state authority, be empowered and directed to make proper provision for the burial of such wires.

"The committee endeavored to secure the attendance of Thomas A. Edison as a witness, but were unsuccessful. Among the witnesses examined were the following: Edward H. Johnson, late president of the Edison Electric Light Company, and Mr. Bowker, first vice-president of the Edison Illuminating Company, representing the Edison interests; Geo. W. Hebard, president of the United States Electric Lighting Co.; C. H. Jackson, president of the United States Illuminating Company; Wm. H. Browne, manager of the United States Light and Power Co., Jacob Hess, commissioner, and Daniel L. Gibbens, late commissioner of the Board of Electrical Control, of the city of New York; Henry D. Kearney, engineer, and Schuyler S. Wheeler, electrical expert of that board; Edward Martin, inspector of the New York Health Department; two representatives of the New York Board of Fire Underwriters, Coroners Schultze and Levy, Thomas Costigan, chief clerk of the District Attorney's office; Professor Plympton, professor of physics in the Polytechnic Institute and president of the late Brooklyn Board of Electrical Commissioners; Dr. Henry Morton, president of Stevens Institute of Technology, Hoboken, N. J.; Dr. George H. Benjamin, electrical expert, and William Maver, jr., electrician of the Consolidated Telegraph and Electric Subway Company of New York.

"In view of the fact that this is the first investigation of the kind ever made in this country, and considering the value of the testimony taken and the numerous inquiries already made for the same from this and other states, it appears proper to ask that it be printed.

"Dated March 21, 1890.

"(Signed)—Geo. Z. Erwin, C. P. Vedder, H. J. Coggeshall, G. G. Van Gorder, Norton Chase, W. L. Brown, Jacob A. Cantor."

Mr. Erwin asked that the report be printed, as there was a general demand for it. A bill was in preparation to meet the suggestions of the report. He moved that the report be adopted. Mr. Jacobs protested that it was too important to be acted on until printed, so Mr. Erwin withdrew his motion, and the report was made a special order for Thursday, April 3.

LEGAL NOTES.

JUDGE COXE'S DECISION IN BRUSH vs. JULIEN.

UNITED STATES CIRCUIT COURT, SOUTHERN DISTRICT OF NEW YORK.

The Brush Electric Co.
vs. } *In Equity.*
The Julien Electric Co., *et al.*

COXE, *J.:*

This is an equity action, for the infringement of four letters patent, granted to Charles F. Brush, for improvements in secondary batteries, and now owned by the complainant. These patents are numbered and dated as follows:—

Nos. 337,298 and 337,299, were applied for June 13, 1881, and were granted March 2, 1886. No. 260,654 was applied for June 13, 1881, and was granted July 4, 1882. No. 266,090 was applied for June 9, 1881, and was granted October 17, 1882.

The first of these, No. 337,298, which is distinguished as Case I., relates to secondary batteries, and consists in a plate or support provided with a mechanically applied coating of absorptive substance to be transformed into an active coating. Also, in a plate or support provided with a mechanically applied coating of granulated, spongy, or porous metallic lead. It further consists in the method of constructing plates for secondary batteries, consisting in mechanically coating lead, or other suitable plates, with an absorptive substance adapted to be transformed into an active coating. The drawings attached to the specification represent the supports in various forms. They show plain, studded, honey-combed, corrugated and ribbed plates; plates with angular corrugations, arranged singly or in pairs, and plates with slots or perforations extending through the plates. The active material consists of granular, porous or spongy lead, which is held in position upon the plain plate of lead by a sheet of heavy paper, card-board, cloth or felt, which may be secured to the plates by rivets, ties, or binding strips of wood or metal. The paper or felt may be dispensed with, and the spongy lead held in position on both sides of the support by subjecting it to pressure, hydraulic or otherwise. In the corrugated, grooved, ribbed, perforated, studded or cellular plates the spongy lead may be held in the grooves, cells, or cavities by paper or felt, or it may be rammed or pressed into them.

The specification states that "when a pair of plates are associated together to form a secondary battery, and immersed in dilute sulphuric acid and charged by the passage of an electric current in the usual manner, one of the plates absorbs a large quantity of hydrogen, while the other plate has its spongy or granular portion peroxidized, and thus forms the oxygen element in the battery."

The claims alleged to be infringed are the first, fifth, eighth, tenth and eleventh. They are as follows:—

"1. A suitable plate or support provided with mechanically-applied absorptive substance and adopted for use as a secondary battery element or electrode after being rendered active by an electric current, substantially as set forth.

"5. An improvement in the construction of a secondary battery element or electrode, said improvement consisting in a plate or suitable support provided with grooves, receptacles, or perforations primarily coated, combined, or filled with mechanically-applied absorptive substance, substantially as set forth.

"8. In the process of making plates or elements for secondary batteries, primarily and mechanically applying or combining with a suitable plate or support an absorptive substance adapted to be transformed into active material, substantially as set forth.

"10. In the process of making a secondary battery plate or element, combining by means of pressure an absorptive substance and suitable material to form a support therefor, substantially as set forth.

"11. In the process of making a secondary battery plate or element, constructing a suitable plate or support with grooves, cells, receptacles or perforations, said plate or support having an absorptive substance primarily applied thereto or combined therewith, substantially as set forth."

The second, No. 337,299, which is distinguished by the inventor as Case J, is for the same invention, substantially, as Case I. The drawings of the two are identical and the language of the specifications is very similar; where it differs, equivalent expressions are employed.

Perhaps the principal differences are the substitution of the words "active material" for the expression "absorptive substance adapted to be transformed into an active coating," of Case I, and the words "lead oxide" for the "granular or porous lead," of Case I.

The specification in question contains this additional statement:—

"Peroxide is the best oxide of lead to use in the preparation of the plates; but as this is rather expensive to prepare, red lead or minium may be used. Some sulphate of lead is liable to be formed when this oxide of lead is employed, by the section of the sulphuric acid of the battery on it before peroxidation or reduction is effected. Protoxide of lead or litharge may also be used, but is objectionable, on account of the large quantity of sulphate of lead which is unavoidably produced by the action of the acid on it."

And also the following:—

"I would have it understood that I do not restrict myself to any particular form of active or absorptive material, or to any particular method of applying it to or combining it with the plate or support, as my invention consists, broadly, in a secondary battery plate or element having active or absorptive material primarily and mechanically applied thereto or combined therewith, as contradistinguished from a plate or element having the active material produced by the disintegrating action of electricity, as in the well-known Planté process."

The claims alleged to be infringed are the first, second, third, sixth, seventh, eleventh, twelfth and thirteenth. They are as follows:—

"1. A secondary battery element or electrode consisting of a plate or suitable support primarily coated or combined with mechanically-applied active material or material adapted to become active, substantially as set forth.

"2. In a secondary battery, an electrode consisting of a plate or support provided with a coating or surface layer of an absorptive substance, such as metallic oxide, applied thereto, substantially as set forth.

"3. A plate or suitable support primarily coated or combined with mechanically-applied oxide of lead or equivalent lead compound, substantially as set forth.

"6. A plate or suitable support provided with grooves, perforations or receptacles, and primarily coated, combined or filled with mechanically-applied active material or material adapted to become active, substantially as set forth.

"7. A plate or suitable support provided with grooves, perforations or receptacles, and primarily coated, combined or filled with mechanically-applied oxide of lead or equivalent lead compound, substantially as set forth.

"11. In the construction of secondary battery elements or electrodes, a plate or suitable support primarily coated or combined with mechanically-applied red lead, substantially as set forth.

"12. The method of making plates or electrodes for secondary batteries, consisting in primarily combining active material with suitable plates or supports mechanically, in contradistinction to forming the active material by an electrical disintegration of the plate or support, substantially as set forth.

"13. The method of making plates or electrodes for secondary batteries, consisting in coating the plates or supports with red lead prior to their immersion in the battery fluid, substantially as set forth."

These two patents, Nos. 337,298 and 337,299, are fundamental patents designed to cover the broad inventions of Mr. Brush.

No. 260,654 is a division of Case J and is distinguished by the inventor as Case J, Division A.

The invention "consists in the method of making the plates of a secondary battery consisting in forming receptacles for oxide of lead in its surface, then applying oxide of lead to the plates and within such receptacles and afterward subjecting the oxide of lead to pressure."

The drawings of this patent are identical with those of the preceding patents, except that Fig. 1, showing the use of cardboard or felt, is omitted.

The specification contains the statements above quoted from Case J, relative to peroxide being the best oxide of lead to use, and says, further, that the oxide of lead may be retained in place by being rammed or pressed into its receptacles, cells or grooves.

The single claim is as follows:

"The method of forming the plates of a secondary battery, consisting in forming receptacles for oxide of lead in its surface, then applying oxide of lead to the plate and within such receptacles, and afterward subjecting the oxide of lead to pressure."

In No. 266,090, distinguished as Case C, the invention consists in a secondary battery element, constructed of cast-lead or other suitable substance, having cells, receptacles, ribs or projection in its surface, whereby an extended surface of metal is exposed to action.

The drawings are the same as those attached to the preceding patents, with some new ones added, showing the plates arranged ready for charging.

The specification says of Fig. 4 that it shows a modified form of ribbed plate resembling an ordinary window-blind with the slats open. It may also be regarded as a thick plate perforated with a series of parallel slots. And of Fig. 5, that it shows the honey-comb form of plate, resembling in construction a simple or double comb of beeswax. It may have its cells extending entirely through the plate.

The plates may be made by pressing plain sheets of lead or other suitable metal into dies or forms by hydraulic or other means, also by slotting, punching or otherwise perforating suitable plates, and also by casting the melted metal into suitable molds.

The claims alleged to be infringed are first, third, fourth, fifth, sixth, seventh, eighth, ninth, twelfth and fourteenth. They are as follows:

"1. In a secondary battery, an element or electrode made up of a series of ribs, substantially as and for the purposes set forth.

"3. A secondary battery element or electrode having its body support or frame provided with ribs.

"4. In a secondary battery, the combination, with one cell thereof of two or more ribbed plates or elements, substantially as set forth.

"5. In a secondary battery, a plate, frame, or other sustaining body provided with ribs or their equivalent, of a less general thickness than the said plate or support, substantially as set forth.

"6. In a secondary battery, a plate, frame or other sustaining body provided with ribs or their equivalents, said ribs or their equivalents being thicker at their bases than at their free edges or ends, substantially as set forth.

"7. A secondary battery element or electrode having its frame, support or body provided with cells or cavities, the walls of said cells or cavities, or the septa, between them having an increasing thickness from their outer or free edges inward.

"8. In a secondary battery, plates or elements provided with comparatively thin ribs, or their equivalents, for surface exposure, and thicker ribs suitably disposed for supporting or stiffening purposes, substantially as set forth.

"9. A secondary battery having a body frame or support of cast-lead.

"12. A secondary battery element or electrode having a supporting body or frame of cast-lead for the active coating or substance, said body or frame provided with ribs or projections.

"14. A secondary battery element or electrode having a supporting body or frame of cast-lead for the active coating or substance, said body or frame provided with slots, perforations, or openings."

The defendants have made, used and sold secondary or storage batteries composed of a series of electrodes, consisting of a cast metal support plate, 96 per cent. being metallic lead, and an exterior spongy or porous coating of mechanically applied active material consisting of lead oxides. These electrodes are placed in an electrolyte of dilute sulphuric acid in water. The charging current converts the lead oxide coating upon the oxygen plates into peroxide of lead, and reduces the lead oxide coating upon the hydrogen plates to the condition of spongy or porous metallic lead. The battery is capable of numerous charges and discharges, in the course of which the active material undergoes successive reductions and reoxidations. The lead oxides used consisted generally of minium and litharge, the former largely predominating in the mixture applied to the oxygen plates and the latter predominating in the mixture applied to the hydrogen plates.

The defenses to all of these patents are anticipation, want of novelty, lack of invention, abandonment (except of No. 260,654), and that the claims have been fatally broadened. As to cases I and J, it is said that the scope of the original applications had been unlawfully enlarged; that the patents expired with an Italian patent to Brush containing the same invention, and, finally, that they are for the same inventions, and that one of them is, therefore, void.

It is also insisted that No. 266,090 is limited by the Italian patent. Invalidity and non-infringement of several claims are alleged.

Are cases I and J for the same invention, and, if so, what course should be pursued regarding them? It will simplify the controversy to answer this question at the outset.

As stated above, the drawings of the two patents are the same, and the language of the specifications and claims are substantially alike upon all matters material.

The contention of the complainant is that Case I is for a secondary battery support mechanically coated with an *absorptive material*, and case J for a similar support coated with an *active material*; "the distinction between the two relating to the condition and inherent capacity of the material of the coating as that material exists at the time of mechanical application." For instance, the spongy lead of Case I has, it is said, no oxygen and is initially absorptive and inactive, while the peroxide of Case J is a fully saturated oxygen compound and is, therefore, active and non-absorptive. It is admitted that the moment a battery, constructed with plates having either coating, is charged or discharged, all distinction vanishes.

"The fundamental distinction between these patents," says the complainant's brief, "is that in the former the coatings of the secondary battery electrodes, are, broadly, mechanically-applied *absorptive substance*, while in the latter these coatings are that class of mechanically-applied absorptive substance defined as active material."

Therefore, both patents, it is argued, are valid.

This question, though it is an accurate statement of the difference between the two, would seem quite tantamount to an assertion that a party may have a patent for a device composed of a combination of iron and wood and a second patent for the same device composed of iron and basswood or hemlock.

One who has a patent for a combination, one element of which is an adhesive substance, may not have a second patent for a combination, identical in every respect, except that the adhesive material suggested must be moistened before it becomes adhesive.

The coatings of both patents being absorptive and active, is the fact that one, prior to immersion in the electrolyte, *has* absorbed, and that the other *will at once* absorb, a sufficient dissimilarity upon which to base invention? Is it a patentable distinction? The difference is one which would hardly occur to a practical electrician, and even specialists enthusiastic in the cause of the patent find it difficult to state it in words which are intelligible to ordinary men. It is too esoteric, metaphysical and minute. It is a mere theory of the scientists, and not a fact upon which to found a patent.

The essence of Brush's broad invention was an improvement upon the secondary batteries of Planté, by adding the porous layer mechanically to the supports, in the manner described, instead of forming it by the tedious and inefficacious process of disintegration in the body of the plates themselves. When he is thoroughly protected in this invention he has received all that he is entitled to. By taking two patents he should not be permitted to multiply claims which could not stand side by side in one and the same patent.

There seems to be little controversy that *absorptive substance* and *active material* are used in the art as synonymous and equivalent terms, and have been so used since the time of Planté. The inventor, himself, apparently so understands it, for he has frequently used them interchangeably, not only in his testimony, but in the patent (Case J) itself.

Professor Barker says: "To a person skilled in the art, as it seems to me, the terms are only different forms of expression for one and the same thing. A secondary battery electrode, such as is contemplated in these patents, can consist of but two essential parts: (1) the material of the coating which gives to the battery its usefulness, and to which is due its capacity of storing electrical energy, and (2) the conducting frame or support upon which this material is spread. Since upon the former the action of the secondary battery depends, it has become the general practice to speak of it as the 'active material' of the electrode, in contradistinction to the support of the plate itself, which is or should be inert. The function of the coating is to change its chemical condition, as, for example, its state of oxidation, so far as to vary this condition in one direction in charging and in another on discharging. . . . Since, in my judgment, granular, porous or spongy lead, the substance of the first patent is 'active material or material adapted to become active' in the words of the second: and since the oxides of lead of the second patent 'are absorptive substances adapted to be transformed into an active coating' in the first, I am of the opinion that the 'absorptive substance' of the first patent and the 'active material' of the second are to be understood as equivalent terms." The Court is fully satisfied that this conclusion is correct.

The identity of the two patents can best be illustrated by placing similar claims in juxtaposition; the first claim of Case I, and the first and second claims of case J. for instance:

Case I.	Case J.
1. A suitable plate or support provided with mechanically-applied absorptive substance and adapted for use as a secondary battery element or electrode after being rendered active by an electric current, substantially as set forth.	1. A secondary battery element or electrode consisting of a plate or suitable support primarily coated or combined with mechanically-applied active material or material adapted to become active, substantially as set forth.
	2. In a secondary battery an electrode consisting of a plate or support provided with a coating or surface layer of an absorptive substance, such as metallic oxide, applied thereto, substantially as set forth.

There can be no question, if "absorptive substance" and "active material" are equivalent terms, that these claims are for the same invention. Each has the following elements: (1) A secondary battery support plate, (2) mechanically coated with (3) an absorptive or active material.

The question, then, is, Can a patentee who has received a patent for a plate coated with absorptive substance obtain another patent for the same plate coated with active material? Can an inventor obtain two patents for a broad invention because in one he practices the invention with one substance, and in the other he practices it with an equivalent substance? Manifestly not!

After Case I no one could have a patent for Case J, even if confined solely to the points wherein the two are said to differ. The former includes the latter. I am constrained to say, therefore, that the two patents are, in legal contemplation, the same. Although the possibility that the court might reach the conclusion was stated at the argument, neither counsel offered any solution of the difficulty and none has been offered since. The situation is certainly an unusual one. Here are two patents for the same invention applied for at the same time and granted at the same time. It is true that no injury can result in this particular instance, but what would be the situation if one of these patents were owned by a third party and a suit were brought on it against the defendants for the same infringement, or if the second patent were granted years after the first? If the principle is once established that an inventor can, by such inconsequential changes as here are shown, obtain two patents for the same invention, the greatest injuries may be done, both to competitors and to the public.

It would seem that the inventor had given Case I the preference; and as his expert regards that as as the broader of the two patents, the difficulty might be met by a surrender of Case J, or perhaps by a disclaimer of similar claims in Case J, leaving those which have not been brought into controversy or considered, and, possibly, the red lead claims, to stand. But, as neither counsel has expressed his views on this subject, the method of carrying out the opinion of the Court can best be arranged on the settlement of the decree.

Many of the propositions now advanced were examined and decided, upon identical testimony, by this Court, in the case of The Electrical Accumulator Co. *vs.* The Julien Electric Co. *et al.* 38 Fed. Rep., 117. These need not be again considered.

A definition of a secondary battery was there attempted and is now adopted for the purpose of this controversy. When the present inventor refers to a secondary battery he means precisely what Mr. Faure meant when he used that term.

It was further decided in the Accumulator case, that the exhibits which were the closest approximations to the invention were the article from the *Electrician* of 1863, the report of the Smithsonian Institution for 1856, the Grove gas battery, Planté's descriptions of 1872, and the patents to Kirchhof and Percival. Faure's claim, before being limited by a disclaimer, was broad enough to cover a secondary battery electrode to which the active material was applied, not only mechanically, but by galvanic action, chemical precipitation or in any other way, so that it was not formed out of the plates themselves in the manner described by Planté.

The evidence referred to, together with the testimony of Mr. Brush, was regarded as sufficient to limit the Faure invention to the application of the active material in the one form described by him, namely, as a paint, paste or cement. What effect the evidence disclosing the prior art had upon the patents in suit was, of course, not directly considered.

In the complainant's brief considerable space is devoted to the establishment of the proposition that Brush was, in legal contemplation at least, prior to Faure. It is thought that a discussion upon this point is unnecessary. The precise question was presented and decided in the interference proceedings before the Patent Office and in the Accumulator case. The defendant's counsel having there contended that Brush anticipated Faure, recognizes the impropriety of now contending that Faure anticipates Brush, and merely submits the testimony in this behalf without comment. The decision heretofore made upon the same state of facts will, therefore, be adhered to.

It was there decided—although the date was not definitely fixed—that Faure, being a citizen of France, and having received his invention in a foreign country, was not permitted to claim it here earlier than the date of the delivery of his French patent—Dec. 7, 1880. Faure's contributions to the art need not, therefore, be considered in this action.

The proof now offered to establish invention was carefully examined in the Accumulator case, and it was held that "the evidence of Mr. Brush as to what he accomplished in 1879 and 1880 must be accepted as true."

What did Brush accomplish?

A history of his experiments and their results is given at length in the other case (pages 129, 130, 131), and need not be again repeated. In brief, it is this: In the summer of 1879, he made secondary battery electrodes, by applying to suitable plates an active or absorptive coating consisting in three instances, respectively, of metallic lead in the form of a fine powder, red oxide of lead, and litharge. These coatings were held in place by a piece of blotting paper, a strip of wood and a string wound tightly around the whole. In July, 1880, he made lead plates with deep grooves; into the grooves of some he rammed yellow oxide of lead and in others sulphate of lead. In September, 1880, he made six plates grooved by a gang of circular saws, and filled the grooves of two by ramming them full of litharge, and of two others by ramming them full of sulphate of lead. The electrodes thus constructed operated successfully in secondary batteries and produced satisfactory results.

Many other structures leading up to the invention were made, but it is not necessary to consider them in detail. It may be said, however, that from the time the idea first entered his mind until the applications were filed, Mr. Brush was engaged, almost constantly, in progressive experiments and investigations.

For the reasons stated in the Accumulator case it is thought that this invention is not anticipated by the testimony of Professor Van der Weyde, the article from the *Electrician*, the Smithsonian report, the Grove battery, or the patents of Kirchhof or Pulvermacher (39 Fed. Rep., 490).

It was said of the patent granted to George C. Percival, April 3, 1866: The idea of Percival also, as shown in his United States Patent No. 53,668, was to improve on Planté's method by saving time and expense. He describes a secondary battery consisting of one pair of electrodes placed in a water-tight wooden box, divided in its centre by a porous partition. On each side of this partition is a layer of powdered gas carbon. These layers constitute the two electrodes, and when in use they are wet by a proper solution. For convenience in establishing connection with these layers there is on each end of the box a screw cup fastened to a strip of copper which is in contact with the carbon. "Lead or any other suitable metal in the form of a coarse powder may be substituted for the gas carbon. This appears to be somewhat analogous to some of the forms described by Faure. The complainant contends that the reference is valueless for the reason that there is no suggestion of a conducting support plate like Faure's, which holds the active layer and conducts electricity to each and all parts of it so that the whole material instantly becomes spongy and thus capable of receiving and discharging electricity. In short, that the Percival battery is without the Faure support plates." (Accumulator case, 38 Fed. Rep., 126.)

It is argued that this patent is an anticipation of claims 1 and 8 of Case I. This is probably true, if a very broad construction is placed on these claims, but there is nothing in the record requiring such a construction. There is no evidence that a Percival battery was ever used or could be made operative. His invention does not seem to be on the line subsequently followed by Brush. He has no plate or support at all resembling those of the Brush patents. He has no *coatings*. His two copper connecting slips *support* nothing. The pulverized gas carbon is not mechanically applied to them; they are simply in contact with the gas carbon. Their presence is not necessary; they are put there for greater convenience only. Percival's electrodes are not coated supports at all; they are cells filled with coarse conducting powder and divided by a porous partition.

Percival's claim is for:

"The forming of the electrodes of a secondary pile of layers of gas-carbon or some other conducting powder, substantially as, and for the purpose herein before described."

Is it not clear that he did not have in mind a lead, or other suitable plate with a layer or coating of active material mechanically applied thereto?

It would seem, then, that nothing in the record anticipates the Brush patent, Case I, when a construction commensurate with the invention is placed upon it.

He did not invent secondary batteries or electrodes for such batteries having a layer of active material, or the use therein of a conducting powder, but he seems to have been the first in this country who held the absorptive substance, in the form of dry powder, in place on the supports by paper or equivalent material, and the first who rammed or pressed it into grooves or receptacles in the plates.

The invention of Case I was not abandoned by descriptions in Patents No. 261,512 and 261,995, granted to Mr. Brush, respectively, July 18 and August 1, 1882.

There is no evidence as to when the applications for those patents were filed, other than the date appearing upon the specification, and this would seem to be insufficient proof of the fact. But accepting this date, June 9, as the true one, only four days elapsed before the filing of the application of Case I—June 13.

The inventor was not responsible for the delay in the Patent Office, which was occasioned by interminable interference proceedings between him and other inventors. His intention not to abandon is demonstrated by the fact that the application for the patent in suit was made out and sworn to two days before the application for the prior patents were filed.

In Holmes *vs.* Alarm Company, 33 Fed. Rep., 254, this Court decided that where a patent fully describes an invention which could be claimed therein, and makes no reservation and gives no warning to the public, a second patent granted upon an application filed months after the first patent was issued, which claims simply the invention previously made public, is invalid. But the Court also used the following language, which seems quite applicable here:

"This is not the case of a patentee who has made application for the second patent before the first is issued. It would be manifestly unfair to hold him responsible for the action of the Patent Office in this regard."

It is thought no authority can be found holding an invention abandoned upon such facts as are here developed. I should be sorry to make a precedent now which can have little but the most technical reasoning to support it.

The patent is not invalidated by the introduction of the descriptive term "absorptive substance" after the original application was filed. The claims as originally stated use the language "mechanically-applied porous, granular, spongy or equivalent lead." The claims as issued substitute the words, "mechanically-applied absorptive substance." This did not change the invention. It was the employment, simply, of more apt and artistic terms for the comparatively clumsy language of the original.

It is argued that claims 5 and 11 of Case I have been unlawfully expanded by the insertion of the word "perforations" therein. Neither the specifications, claims or drawing, as originally filed, mentioned perforations extending through the plate. They first appear in an amendment filed June 1, 1882.

Prior to this, in the summer of 1881, Professor Eaton had made perforated secondary battery plates. (Accumulator case, 38 Fed. Rep., 141.) John S. Sellon and Joseph Wilson Swan had described similar plates in their patents of March 10, 1882, and Nov. 22, 1881, respectively.

It is not contended that Mr. Brush ever made such a plate. There is no proof that he did, and he testifies that he cannot recall having done so.

The value of perforations extending through the plate seems to be conceded. Proof of the advantages of this construction appears in the record and the language of Sir William Thomson, who testified in the previous case, may be adopted as an epitome of what is affirmed by the witnesses here. (See Accumulator case, 38 Fed. Rep., 140.)

The complainant's brief contains the following:

"Thus perforations may, in his view, be a specific improvement over recesses or receptacles broadly considered, but recesses broadly considered in combination with the mechanically applied active or absorptive material in a secondary battery is the subject of the claims now under consideration." And again, "As to the improvement in recessed plates, which consisted in carrying the recesses through the plates and forming perforations, Mr. Brush has no separate claim for that specific improvement. Defendants insist that Swan has the prior right to that specific improvement. Brush's claims are for the broad ground of a recess, and it may be that Swan is entitled to be considered the first who carried the recess through the plates, making a recess which was also a perforation. But that question does not arise here."

But it seems that the question does arise. The claim is certainly susceptible of a construction covering a plate containing receptacles not only, but also perforations which go entirely through the plate. In other words, it may be construed to cover the features Mr. Brush is entitled to as well as the one he is not entitled to. So construed, an infringer, after paying complainant for the use of the recesses which belong to Brush, might also be compelled to pay for perforations which, so far as this patent is concerned, belonged to some one else—Eaton, Sellon or Swan. Neither of these gentlemen, if he had a patent for this specific improvement, could prevent complainant from using perforations as distinguished from recesses.

The common meaning of "perforation" is a hole or aperture through a body. It is argued that the patentee intended that this meaning should be adopted, for he says: "Fig. 8 shows a vertical section of a ribbed plate provided with slots or perforations extending through the plate." And yet, other parts of the specifications would indicate that he intended to make no distinction between perforations and receptacles. As before stated, the language quoted first appeared a year after the original application was filed. The Court has grave doubt, therefore, whether these facts do not bring the case within the rule laid down by Railway Co. *vs.* Sayles, 97 U. S., 563; Kittle *vs.* Hall, 29 Fed. Rep., 508, 514 and cases cited.

But consideration should be given to the unusual circumstance attending the filings of so large a number of applications and drawings at or about the same time. The inventor seems to have thought that by cross-references the information contained in all could be imported into each separately. This, certainly, bears upon the question of intent. The drawings which he afterwards filed in Case I were in fact filed with Case C, and were in the Patent Office when the application for Case I was filed. The third claim, as originally proposed, covered a ribbed, honeycombed or equivalent plate. If the claims as finally allowed may be fairly construed to cover nothing more than a honey-combed or equivalent plate, which certainly contemplates a plate containing cells or cavities, can it be said that the claims in question have been fatally expanded?

It is true that the ordinarily accepted meaning of the word "perforation" would imply an opening extending entirely through the plate, and such an opening the inventor could not engraft upon the original application. But the word may also have a meaning synonymous with "cavities" or "cells;" it may mean a hole not passing entirely through, but into the centre or interior, and a plate with such perforations the inventor was at liberty, it would seem, under the original application.

Such a construction does not interfere with the rights acquired by the public for it does not admit a broadening of the claim. It holds the inventor strictly to what he asked for in the first instance.

When, by a liberal construction, a patent may be sustained, is it not the duty of the Court to adopt it rather than one which, though possibly more plausible, will deprive the patentee of the fruits of a meritorious invention to which he is fairly entitled?

With considerable hesitation I shall hold that these claims, as thus construed, are valid. That they are infringed there can be little doubt. The defendants' electrodes have receptacles; they may be improved receptacles, but they are receptacles nevertheless. These claims do not cover the improvement.

Regarding the pressure claims, so called, the defenses are that they are void for want of intention, and if a construction is placed upon them sufficiently narrow to enable them to stand, the defendants do not infringe.

The tenth claim of 337,298 is as follows:

"10. In the process of making a secondary battery plate or element combining, by means of pressure, an absorptive substance and suitable material to form a support therefor, substantially as set forth."

The only claim of No. 260,654 is as follows:

"The method of forming the plates of a secondary battery, consisting in forming receptacles for oxides of lead in its surface then applying oxide of lead to the plate and within such receptacles, and afterward subjecting the oxides of lead to pressure."

The latter is a narrower claim than the former, being limited to oxides of lead, to support plates having receptacles and to pressure after, and, therefore, in addition to, the mere mechanical application.

It is not denied that the prior art plainly reveals the use of pressure in making primary battery plates. The distinguishing feature of the invention of these claims is *pressure*. Every other element is covered by other claims. It is argued with plausibility and force that it is not invention for the patentee, with the coated plate before him, to subject it to treatment which he could easily have learned from Laclanché and others.

It is said that the function of pressure is the same whether used on a primary or secondary battery electrode, and that the claim cannot be upheld by importing into it all the valuable features of the broad invention.

It is contended for the complainant, on the other hand, that pressure applied to secondary battery plates produces an entirely different result and performs an entirely different function from that produced when applied to primary battery plates.

If the claims are limited to the use of hydraulic, or other similar pressure, the Court, as now advised, would be inclined to recognize the force of the complainant's contention.

But the construction asked for is broad enough to cover the application of the absorptive material with trowel or spatula and the incidental pressure attending this operation.

Says the complainant's expert: "In the plates of defendants' battery I find a series of small cells perfectly filled with an apparently uniform and extremely even mass of absorptive material. I know of no way in which this could have been effectively done except by spreading and forcing into the perforations the absorptive substance, either in the form of a paste or of a powder; generally the application of the absorptive substance to the plate is accomplished by means of a trowel or spatula; the support is usually laid upon a slab or some material such as slate or glass, and the absorptive material, in the form of powder or paste, is spread over the plate and forced into the perforations; considerable pressure is always applied to the material to force it into the receptacles; the excess of material is removed by a spatula or some equivalent implement, and the plates are then quite smooth, the absorptive material at the receptacles having almost the thickness of the support plate. From a careful examination of defendant's batteries and from my general knowledge as to the methods employed, I am of the opinion that the absorptive material has been applied in substantially the manner of the tenth claim above described, and that considerable pressure has been employed in the operation."

There can be no doubt that a construction as broad as here demanded would invalidate the claim. It would cover a well known and exceedingly simple operation. It would cover the mechanical application of the coating. It is hard to conceive how it could be made to adhere without some degree of pressure. Even the blotting paper, stick and string of the 1879 electrode would infringe. Pressure such as this, it is believed, was not contemplated by the inventor. He had in view pressure, plus the chemical application, by means of which the coating would adhere more perfectly not only, but by which better conductivity could be obtained.

But if the narrower construction is given these claims, the defendants do not infringe; at least they have not been proved infringers.

I do not lose sight of Mr. Weston's later testimony taken April 8, 1889, but it seems to me that it adds nothing to his former statements upon which the Court would be warranted in acting. It is hearsay merely and wholly indefinite as to time. The bill was filed in April, 1887, alleging that before the commencement of the action the defendants had infringed. This allegation is hardly sustained by the testimony of a witness taken two years later that he has been informed that the defendants have infringed for "some time."

The stipulation signed by the defendants' solicitors, designed to cover undisputed matters upon the subject of infringement, makes no mention of pressure.

Case C, No. 266,090, contains two classes of claims. The first class (claims 1 to 8 inclusive) relates to the form of the plates; the second class (claims 9, 12 and 14) to the material of which the plates are formed.

Claim 7 relates to a secondary battery electrode having its support provided with "cells or cavities;" other claims of the first class relate to "ribs."

Claim 14, in addition to the element of cast-lead, has also the element, not elsewhere claimed in this patent, of "slots, perforations or openings."

It is said that the defendants do not infringe the claims of the first class, other than the seventh, for the reason that they do not have a ribbed support plate. The language of the seventh claim described with much greater precision the defendants' supports than that of any other claim of this class. They certainly use cells or cavities. Whether they use ribs or not is, at least, doubtful.

If there were nothing in the art but the contributions of Mr. Brush, it is evident that a narrow construction must be given to these claims. Every word by which even a shade of distinction in the formation of these plates can be expressed, has been adopted. Advantages of the most surprising and mysterious character are said to lurk in the slightest change of size, shape or depth in the holes or recesses. In these circumstances a different rule should be adopted than if the art showed that all these methods of keeping the active material in place are, substantially, equivalent.

The defendants use a support filled with rows of uniform square holes. The Court is not prepared to say that the walls between these holes are ribs. The ordinary meaning of the word would have to be strained and distorted to make it cover "partitions or septs between the cavities," and especially so in an art where a restricted meaning is required. A careful reading of the specification confirms the impression that the patentee intended to use the word, not as now asserted, but in its ordinary sense, as synonomous with projections or ridges. He intended to draw, and does draw, a sharp distinction between plates with ribs and those with cells, cavities and perforations.

Claims 9 and 12 are clearly void for want of patentable novelty. Their only distinguishing feature is cast-lead. The complainant, if its position is correctly understood, does not assert that there is anything patentable in casting lead. It is not alleged that the eleventh claim, which covers the process of casting, is infringed. Not only every skilled mechanics but every schoolboy who has experimented with melted lead, who was shown a model of defendants' grid, and asked to make a series of them, would at once suggest the idea of casting them in molds. This proposition is, virtually, conceded by the complainant's counsel, for in speaking of the advantages of casting over rolling or pressing, they say: "If this latter were the only advantage and the only mode of operation and result then the invention would be old in any casting of a complex form, and that is the plane on which defendants deal with this invention; but the true understanding of the invention shows that it had its birth in the needs of secondary batteries that operate by expansion and contraction of a permanent coating which must be allowed to get away from its support, and that its peculiar mode of operation and advantages exist only in such a battery."

What, then, is the novelty upon which these claims are sought to be sustained? It would seem to rest solely on the theory that cast-lead produces better results on a secondary battery than rolled or pressed lead. A patent cannot stand for a moment upon ground so narrow. Lead plates were old in secondary batteries, cast-lead plates were old in primary batteries. The art of casting was old and free to all. The form of the plates desired would suggest casting them to the skilled artisan. This right being clear, it is idle to assert that one may cast his plates, but shall not be permitted to use them after they are cast. It being quite impossible to pour melted lead into molds without producing cast-lead the question arises: Can the person who first uses the obvious process in making secondary battery plates not only obtain a monopoly of the product but of the process as well? Manifestly not! It is not even the substitution of one known material for another. It is the substitution of one well known form for another well known form of the same material.

In Hotchkiss *vs.* Greenwood, 11 How., 243, the Court says: "The improvement consists in the superiority of material, and which is not new, over that previously employed in making the knob. But this, of itself, can never be the subject of a patent. No one will pretend that a machine, made in whole or in part, of materials better adapted to the purpose for which it is used than the materials of which the old one is constructed, and for that reason better and cheaper, can be distinguished from the old one, or, in the sense of the patent law, can entitle the manufacturer to a patent. The difference is formal, and destitute of ingenuity or invention. It may afford evidence of judgment and skill in the selection and adaptation of the materials in the manufacture of the instrument for the purpose intended, but for nothing more."

See also Bushing Co. *vs.* Doelger, 23 Blatchf., 167, and cases cited.

With every disposition to act with liberality toward those who, with undoubted genius and untiring research, are developing this recently discovered mine of industry, the Court cannot ignore the repeated and uniform utterances of the Supreme Court upon the subject:

In addition to the familiar and oft quoted authorities, see the following decided at the present term:

Burt *vs.* Evory, Feb. 3, 1890; Hill *vs.* Wooster, Jan. 13, 1890; Day *vs.* Railway Co., 132 U. S., 98; Watson *vs.* Railway Co., Id. 161; Marchand *vs.* Emken, Id. 195; Royer *vs.* Roth, Id. 201.

Claim 14 may be construed as covering a combination, one element of which, the slots, etc., is new and useful, and is not covered by the other claims. The original specification and drawings, filed June 9, 1881, describe and show grooved, honey-combed and slotted plates. Indeed, the drawings, for the absence of which Case I is criticized, were filed at the outset in case C.

"Of Fig. 4, showing the slotted plate the specification say:

"Here the supporting plate between the ribs is removed, the latter being supported by the heavier side or end ribs and other intermediate transverse ribs if necessary. This modification is in form somewhat like an ordinary window blind with the slats open."

This can mean nothing else except that there were openings extending entirely through the plate. The specification as originally filed is sufficient, therefore, to support the claim, Regarding the infringement of this claim and claim 7 there can be no doubt, and the same is true of the claims in controversy of Case I.

The point is suggested that the defendant Bracken is not proved to be an infringer, but the stipulations signed by the solicitors makes no distinction between the defendants.

The questions arising on the expiration of the Italian patent are of a serious character, and, in view of the elaborate attention given to the other defenses, would seem to demand greater consideration in the testimony and in the briefs. The patent appears in the record, but no word of explanation, so far as can be discovered, has been offered on the part of the defendants. The only testimony explanatory of the patent is the clear and positive statement of the complainant's expert, that it describes and claims inventions entirely different from those of the patents in controversy.

The patent contains five divisions and twenty-two claims. It requires but little expert knowledge to perceive that some of these are wholly dissimilar to the inventions in suit. Others would seem to be dangerously near to some of the inventions, but those portions of the Italian patent, which seem to the Court to be most in point are but little discussed, and in some instances are not even alluded to in the defendants' brief.

For example, take a portion of Division D and its corresponding claims. The Italian patent says:

"To form an element having a core or body coated with the mass described, I take a sheet or other suitable piece of lead, or of other substance suitable for the purpose, and if necessary roughen or score its surface, or pierce it with numerous perforations to insure a firm adhesion of the mass which is to constitute the active coating. I cover it with the finely divided superficially oxidized lead (or the mixture of metallic lead and lead oxide particles) and apply heavy pressure. The result is that the finely divided particles are not only pressed into a firm and strongly coherent mass, but the mass is also firmly united to the supporting core or body. This core may be of lead, or it may consist of non-oxidizable metal, such as gold or platinum, or any alloy of these metals with lead."

Claim 17 of the Italian patent is as follows:

"A process for making secondary battery elements (or material from which said elements can be constructed); said process consisting in covering one, or more, or all of the surfaces of a suitable metallic or electro-conducting core or body, either with superficially oxidized particles of lead, or with a mixture of particles of pure lead and lead oxide, and, afterward, applying pressure sufficient both to unite said particles or mixture into a compact and firmly coherent mass, and to unite the mass to the core or body, as set forth in 'Division D.'"

Bearing in mind the fact that metallic lead and lead oxide are absorptive or active material, a comparison with some of the claims in controversy will certainly show marked features of similarity.

Claim 10 of Case I is as follows:

"In the process of making a secondary battery plate or element, combining by means of pressure an absorptive substance and suitable material to form a support therefor, substantially as set forth."

To the uninitiated it would seem that these claims are for similar inventions. Would not a person, following the formula of the Italian patent, infringe the pressure claims of the patent in suit? Is not the method of making electrodes by pressing active material upon the support set free "by the expiration of the Italian patent?"

It is also true that Division D of the Italian patent describes also the process of uniting the absorptive substance into a compact or firmly adherent body or mass without the intervention of a support plate, but to the ordinary reader it would seem to be reasonably clear that when the inventor says, as in the description quoted, that he takes a sheet of lead, pierces it with numerous perforations to insure a firm adhesion of the mass which is to constitute the active coating, covers the support with the mixture of metallic lead and applies heavy pressure, so that the mass is not only pressed together but is also firmly united to the supporting core, he is describing the process which is covered by the claim in question.

Other claims of the Italian patent are as follows:

"11. As a new article of manufacture, a mass consisting of a mechanical mixture or association of metallic lead and oxide of lead, united by pressure into a coherent and firm body, substantially as set forth in 'Division D.'

"14. For use in an element of a secondary battery, a metallic core, or body, to one or more sides of which is attached a mass or substance, primarily consisting of metallic lead or oxide of lead, united by pressure so as to be strong and firmly coherent, substantially as set forth in 'Division D.'

"15. A secondary battery element, consisting of a metallic core, or body having attached to it a coating primarily consisting of mixed lead and oxide of lead, firmly united by pressure into a strong and coherent mass, substantially as set forth in 'Division D.'

"16. A secondary battery element, consisting of the combination with a metallic supporting core or body of a coating attached or united to said core; said coating primarily consisting of metal-lead and lead oxide in an intimately commingled state, united by pressure into a strong and firmly coherent mass, substantially as set forth in 'Division D.'"

It will be observed that the first of these, Claim 11, covers only lead and oxide of lead mixed and united by pressure into a coherent mass for use as an electrode or as a coating. The element of a support plate is wanting in this claim, but it is present under the name of "a metallic core or body," in all the others.

Compare these claims with the pressure claims of the patents in suit, but also compare them—and particularly claim 11—with claims 12 and 13 of Case I. They are as follows:

"12. Absorptive material for use in secondary batteries formed into a coherent mass by pressure, substantially as set forth.

"13. For use in secondary batteries, porous, granular, spongy, or equivalent lead formed into a coherent mass by pressure, substantially as set forth."

The language is different, but in substance where is the lack of identity?

But all these are questions which the Court, in view of the action of the American and Italian patent officials, in distinguishing between the inventions covered by the Italian patent and those covered by the patent in suit, and in view of the uncontradicted opinion of the complainant's expert, should hesitate long before answering in the affirmative.

Mr. Weston says of "Division D" of the Italian patent:

"It is for an improved form of electrode especially adapted to the foundation by electrical disintegration either by the Planté method or by the peculiar method of electrical disintegration invented by Mr. Brush and described in Division A."

It should be remembered that we are dealing here with a mysterious and occult power of nature, the science of which is still in its infancy, the phenomena of which are but little understood, even by those who have made its study their life work. For one who has but a casual and superficial knowledge to place a construction upon a patent, which is addressed to those who are educated in this department of science, and which constantly employs terms of art, in opposition to the opinion of the only electrician who speaks upon the subject, would be unwarranted especially when such a construction will destroy rights an interests of great value. In very many of the patent causes which come before the courts, where the device is so simple that any man of ordinary capacity can understand it, the presence of an expert is wholly unnecessary, but when the invention relates to a subject where even the pioneers are still groping in shadows, the Court needs the instruction of those most competent to advise, and without such assistance should proceed with the utmost caution. The law does not favor forfeitures. A patent should never be declared invalid because of the expiration of a foreign patent, if there is doubt about the inventions being the same. The burden is upon the defendants and the doubt should be resolved in favor of the patent.

After such study as I have been able to give the subject, I am not satisfied that the Italian patent is for the same invention as those in controversy. It is sufficient, for present purposes, to state that the mind of the Court is in doubt upon the question.

The language of Judge Bradley in the case of Bishof *vs.* Wethered, 9 Wall, 312, where a patent was introduced, as here, without explanation, seems particularly applicable.

"The specifications of patents for inventions are documents of a peculiar kind. They profess to describe mechanisms and complicated machinery, chemical compositions and other manufactured products, which have their existence *in pais*, outside of the documents themselves; and which are commonly described by terms of the art or mystery to which they respectively belong; and these descriptions and terms of art often require peculiar knowledge and education to understand them aright; and slight verbal variations, scarcely noticeable to a common reader, would be detected by an expert in the art, indicating an important variation in the invention. Indeed the whole subject matter of a patent is an embodied conception outside of the patent itself, which, to the mind of those expert in the art, stands out in clear and distinct relief, while it is often unperceived, or but dimly perceived by the uninitiated. This outward embodiment of the terms contained in the patent is the thing invented, and is to be properly sought, like the explanation of all latent ambiguities arising from the description of external things, by evidence *in pais*." It was, therefore, decided that the Circuit Court was right in charging the jury that there was not on the face of the respective patents such an identity as authorized the Court to pronounce that they were for the one and the same invention.

No. 260,654 is not, in any event, affected by the Italian patent. The former bears date July 4, 1882, the latter Aug. 8, 1882, and it was not applied for until July 28, 1882.

It follows that upon filing a disclaimer of the invalid claims the complainant is entitled to a decree in accordance with this opinion, but without costs.

In connection with this decision the following statement should, I think, be made:

A suit similar to this is pending against the Electrical Accumulator Company. Sometime after the oral argument in this cause was concluded, the counsel for that company, after due motion to all parties interested, called the attention of the Court to the following facts:

On the 28th of March, ten days after the decision on the Faure patent was filed, the president and secretary of the Julien Company, without the knowledge or consent of counsel, obtained from the complainant an option to take an exclusive license under the patents in suit provided they were sustained.

In view of these facts the Court was asked either to refuse to decide the case altogether or to postpone the decision until the cause against the Accumulator Company is ready for argument.

The Court urged upon counsel the importance of having the issues passed upon in a controversy which is, in all respects, genuine and earnest, and expressed his own disinclination to decide an action where a suspicion to the contrary might exist. Several plans were suggested, but none upon which counsel could agree. As the option alluded to is not regarded as a settlement of the cause, the conclusion has been reached that justice to the parties demands that a decision should be made at this time.

I regret having to inflict so long an opinion upon litigants and counsel, but the examination and study of a record and briefs aggregating twenty-five hundred printed pages, has made it impossible to devote the necessary time to review and condensation.

AN IMPORTANT DECISION BY THE UNITED STATES SUPREME COURT.

POHL VS. ANCHOR BREWING CO.

On Monday, March 24th, the United States Supreme Court handed down its decision in the case of Pohl *vs.* Anchor Brewing Co., which involves a most vital point in connection with American patents for which foreign patents have also been issued. As our readers are aware, section 4,887 of the Revised Statutes limits the life of the United States patent to the shortest term of the prior foreign patent. Hence the lapse of such a foreign patent, through whatever cause, has heretofore been held to terminate the life of the United States patent, and this view was taken by Judge Wallace in the above case. His decision has, however, been reversed by the Supreme Court in an opinion written by Judge Blatchford. After reciting the pleadings and discussing the case the Court says:

"We think that the question involved in the present case is not the same as that decided in Bate Refrigerating Co. *vs.* Hammond, and is not controlled by the decision in that case. There a United States patent was granted in November, 1877, for seventeen years. A patent for the same invention had been granted in Canada to the same patentee for five years from January, 1877. The Canadian patent was, in December, 1881, extended for five years from January, 1882, and also for five years from January, 1887, under a Canadian statute passed in 1872. The question involved was whether, under section 4,887, the United States patent expired in January, 1882, or in January, 1892. This Court, limiting itself to the precise question involved, said that it was "of opinion that, in the present case, where the Canadian statute under which the extensions of the Canadian patent were granted was in force when the United States patent was issued, and also when that patent was applied for, and where, by the Canadian statute, the extension of the patent for Canada was a matter entirely of right, at the option of the patentee, on his payment of a required fee, and where the fifteen years' term of the Canadian patent has been continuous and without interruption, the United States patent does not expire before the end of the fifteen years' duration of the Canadian patent."

This was said on the view, expressed elsewhere in the opinion, that the Canadian patent did not expire, and it never could have been said properly that it would expire, before January, 1892. The ground of this conclusion was, that the "term" of the Canadian patent granted in January, 1877, was by the Canadian statute at all times a term of fifteen years' duration, made continuous and uninterrupted by the action of the patentee, as a matter entirely of right, at his own option.

"By parity of reasoning, as applied to the present case, section 4,887 requires that the United States patent shall be so limited as to expire at the same time with the term limited by the foreign patent issued prior to the issuing of the United States patent, having then the shortest time to run. There is nothing in the statute which admits of the view that the duration of the United States patent is to be limited by anything but the duration of the legal term of the foreign patent in force at the time of the issuing of the United States patent, or that it is to be limited by any lapsing or forfeiture of any portion of the term of such foreign patent, by means of the operation of a condition subsequent, according to the foreign statute. In saying that 'every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent,' the statute manifestly assumes that the patent previously granted in a foreign country is one granted for a definite term; and its meaning is, that the United States patent shall be so limited as to expire at the same time with such term of the foreign patent. Such term was held, in Bate Refrigerating Co. *vs.* Hammond to be fifteen years and not five years.

"This view is made conclusive by the requirement of section 4,887, that if there be more than one prior foreign patent, the United States patent shall be so limited as to expire at the same time with that one of such foreign patents 'having the shortest term.' This means the foreign patent which, at the time the United States patent is granted, has then the shortest term to run, irrespective of the fact that the foreign patent may afterwards lapse or become forfeited by the non-observance of a condition subsequently prescribed by the foreign statute.

"In the view that section 4,887 is to be read as if it said that the United States patent is to be so limited as to expire at the same time with the expiration of the term of the foreign patent, or if there be more than one, at the same time with the expiration of the term of the one having the shortest term, the interpretation we have given to it is in harmony with the interpretation of the words 'expiration of term' in analogus cases. (Oakley *vs.* Schoonmaker, 15 Wendell, 226; Beach *vs.* Nixon, 9 N. Y., 35; Farnum *vs.* Platt, 8 Pick., 338.) In those cases it was held that the words 'expiration of term' do not mean expiration of term through a forfeiture by breach of a condition, but mean expiration by lapse of time.

"The decree of the Circuit Court is reversed, and the case is remanded to that court with the direction to overrule, with costs, the plea of the defendant, to assign it to answer the bill, and to take such further proceedings as shall not be inconsistent with the opinion of this Court."

This case is one which has been watched with considerable interest by the electrical fraternity, as in one of the suits between the Edison Co. and the United States Electric Lighting Co. a similar plea had been entered to prove the invalidity of the main Edison lamp patent.

The reversal of Judge Wallace's decision gives the American inventor the right to his patent up to the term for which the foreign patent was originally granted, independent of any subsequent causes by which it may have been allowed to lapse abroad.

THE suit which was brought by the Edison Electric Light Company against Westinghouse, Church, Kerr & Company, in 1886, alleging infringement of Edison's patent No. 274,290, for the plan of electrical distribution known as the "three-wire" system, was heard in the United States Circuit Court, at Trenton, New Jersey, on May 10, 1889. Nearly a year has elapsed, but no decision has yet been handed in. The plant at Trenton, which was alleged to contain the infringement was changed over to the alternating system some two years ago, so that the decision when rendered will be of importance mainly as defining the validity and scope of the three-wire patent.

Another suit brought by the Edison company in 1886, against the same defendants, alleging infringement of Edison's patent No. 264,642, commonly known as the "feeder and main system" is still in progress. The complainants have closed their *prima facie* case and the defendants have just commenced taking testimony for the defence.

The suit of the Consolidated Electric Light Co. *vs.* the Edison Electric Light Co., alleging infringement of Sawyer & Man's patent of June 5, 1878, for the method of connecting electric lamps in multiple series, is still in progress. The complainant's *prima facie* case has been closed, and the expert testimony in behalf of the defendants is now being taken.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

From February 18 to March 25 (inclusive.)

Alarms and Signals:—*Annunciator*, T. H. Shipway and J. R. Dowdell, 421,439. *Electrical Annunciator*, A. F. Parks, 421,508. *Time-Alarm*, G. H. Straight, 421,530. *Electric Railway Signal*, W. C. Walter, 421,791. *Automatic Fire-Alarm System*, G. F. Bulem, 421,853. *Automatic Fire-Alarm Transmitter*, same, 421,854. *Visual Annunciator for Call-Boxes*, P. Seiler, 421,882, February 18. *Automatic Railway Alarm and Signal*, M. M. Souders, 421,983, February 25. *Electric Time-Alarm and Annunciator*, N. H. Suren, 422,654. *Electro-Magnetic Annunciator*, C. J. Hamilton, 422,778. *Low Water Alarm for Steam Boilers*, E. E. Kildoyle, 422,803, March 4. *Automatic Electrical Annunciator*, B. F. Shafer, 422,981, March 11. *Annunciator*, C. E. Scribner, 423,494. *Bell*, L. M. Linolet, 423,637. *Electric Bell*, A. F. Stanley, 423,707. *Electric Burglar and Fire Alarm*, W. Gee, 423,758, March 18. *Electric Alarm for Letter-Boxes*, W. G. Reed, 424,219. *Burglar Alarm*, N. M. Watson, 424,387. *Municipal Signaling Box*, F. Pearce, 424,431, March 25.

Clocks:—*Electro-Magnetic Watch-Clock*, R. B. Carr, 424,268. *Electric Time Dial*, C. A. Colby and J. C. Strong, 424,273, March 25.

Conductors, Insulators and Conduits:—*Conduit for Electric Railways*, P. H. Griffin, 421,398. *Electric Conductor*, J. A. Stoughton, 421,781. *Insu-*

lator, J. W. Davy, 421,819, February 18. *Electric Conductor*, E. F. Phillips, 421,968. *Electric Connector*, C. McIntire, 422,058. *Device for Suspending Electric Conductors at Crossings*, S. H. Short, 422,096. *Support for Overhead Electric Conductors*, C. K. Stearns and G. K. Wheeler, 422,164, February 25. *Compound Insulating Layer for Electric Coils*, E. Thomson, 422,550. *Insulator*, G. E. Stanley, 422,651, March 4. *Underground Electric Conduit*, A. Bruner, 423,023. *Laying Electric Conductors*, T. J. Cope, 423,134, March 11. *Crossing for Electric Conductors*, H. A. Seymour, 423,495. *Electrical Conductor*, G. E. Miller, 423,527, March 18. *Underground Conduit for Electric Wires or Cables*, C. G. Gilman, 424,057, March 25.

Distribution:—*Electrical Induction Apparatus or Transformer*, M. Von Dolivo-Dobrowolsky, 422,746, March 4. *Isolated System of Electric Lighting*, J. F. McLaughlin, 424,339, March 25.

Dynamos and Motors:—*Dynamo-Electric Machine*, DeW. B. Brace, 421,479. *Electric Motor*, P. B. Walsh, 421,790, February 18. *Regulating Apparatus for Electric Motors*, P. Diehl, 421,911. *Dynamo-Electric Machine*, M. Pfatischer, 421,967. *Dynamo-Electric Machine or Electric Motor*, E. B. Parkhurst, 422,148. *Electric Motor*, same, 422,149. *Carbon Commutator-Brush and Holder*, C. J. Van Depoele, 422,265. *Pyromagnetic Generator and Motor*, W. B. Cooper, 422,295, February 25. *Armature*, C. D. Jenney, 422,419 *Dynamo-Electric Machine*, R. Eickemeyer, 422,511. *Electric Motor*, H. E. Walter, 422,556. *Armature for Electric Machines*, J. C. Wray, 422,681. *Pulsating Electric Generator*, C. J. Van Depoele, 422,855. *Pulsatory Current Motor*, same, 422,856. *Alternate-Current Pulsating System*, same, 422,857. *Converting Continuous into Pulsating Electric Currents*, same, 422,858. *Pulsating Current System*, same, 422,859. *Multiple-Current Pulsating Generator*, same, 422,860. *Regulating Electric Motors*, G. A. Washburn, 422,862. *Armature for Dynamos*, etc., same, 422,863, March 4. *Electromotor*, H. R. Butterfield, 422,911. *Field Magnet for Dynamos*, E. Thomson and A. L. Rohrer, 422,999. *Armature*, R. L. Cohen, 423,026. *Regulation of Alternate Current Generators*, S. C. C. Currie, 423,029. *Holder for Commutator Brushes*, J. C. Chamberlain, 423,309, March 11. *Alternating Current Electric Regulator*, L. Gutmann, 423,553, March 18. *Constant Current Motor*, W. Baxter, Jr., 423,897. *Regulator for Dynamos*, H. W. Cooley, 423,909. *Commutator Brush*, P. Diehl, 423,912. *Controller for Electric Motors*, M. J. Wightman, 423,975. *Dynamo-Electric Machine*, S. Z. De Ferranti, 423,991. *Commutator*, W. F. D. Crane, 424,406. *Electro-Magnetic Motor*, N. Tesla, 424,036. *Dynamo-Electric Machines*, C. D. Jenney, 424,065, March 25.

Galvanic Batteries:—*Electric Battery*, C. Wilms and G. A. Liebig, Jr., 421,801, February 18. *Automatic Switch for Regulating the Power of Electric Batteries*, G. B. Pennock, 422,438. *Galvanic Battery*, J. H. Linville, 422,534, March 4. *Zinc Electrode for Galvanic Batteries*, G. d'Infreville, 422,925. *Dry Galvanic Battery*, L. Moorthamers, 434,335, March 11. *Galvanic Battery*, M. M. Clark, 423,594, March 18.

Lamps and Appurtenances:—*Arc Light Carbon*, W. E. Adeney and L. Saunderson, 421,469. *Camera and Electrical Flash Light Attachment*, G. E. Davis, 421,484. *Incandescent Lamp Socket*, W. P. Kookogey, 421,586. *Electric Lamp Adapter*, J. Stewart, 421,630. *Carbon for Arc Lamps*, E. L. Liedke, 421,733. *Hanging Device for Electric Lamps*, W. H. Layng, 421,864, February 18 *Exhaust Apparatus for Incandescent Lamp Globes*, H. J. Jaeger, 422,219. *Carbon for Electric Lamps*, H. H. Head and L. Saunderson, 422,302. *Safety Cut-Out*, F. B. Rae, 422,351. *Incandescent Lamp Socket*, W. F. Wollin and E. H. Werline, 422,360, February 25. *Arc Lamp*, G. C. Pyle, 422,446. *Carbon for Electric Lamps*, W. F. Smith, 422,456. *Incandescent Gas Lamp*, J. N. Pew, 422.536. *Suspension Device for Incandescent Lamps*, H. W. Hayden and C. S. Dikeman, 422,591. *Reflector for Incandescent Lamps*, F. Holman, 422,592. *Incandescent Lamp Socket*, F. C. Rockwell, 422,684. *Lighting Fixture*, P. C. J. Lemaire, 422,811. *Manufacture of Carbons for Electric Lamps*, W. F. Smith, 422,895, March 4. *System of Arc and Incandescent Electric Lighting*, H. P. Brown, 422,910. *Portable Electric Lamp*, A. H. Bauer, 423,207, March 11. *Carbon Rod for Arc Lamps*, C. E. Scribner, 423,637. *Cut-Out for Electric Arc Lamps*, same, 423,638. *Arc Lamp*, H. Pieper, Fils, 423,807, March 18.

Measurement:—*Electrical Indicator*, L. Bock, Jr., 421,851, February 18. *Galvanometer*, J. Waring, 422,672, March 4. *Electric Meter for Alternating Currents*, O. T. Blathy, 423,210, March 11. *Ampere Meter*, G. A. Frei, 423,600, March 18. *Electric Meter*, W. McKinney, 424,338. W. J. Bagby, 424,401, March 25.

Medical and Surgical:—*Electric Belt*, M. Wadleigh, 421,457, February 18. *Voltaic Shoe*, C. H. Ayer, 422,107, February 25. *Apparatus for Medicating, Compressing and Administering Air*, J. C. Kennedy, 422,802, March 4. *Electro-Therapeutic Appliance*, C. E. Brunning, 423,549. *Galvanic Apparatus for Dental Surgery*, C. Wm. Manker and G. F. Manker, 423,616. *Electrical Device for Use in Dental Operations*, same, 423,617, March 18. *Therapeutic Galvanic Apparatus*, T. Schmauser, 423,959. *Electro-Medical Chair*, M. A. MacMaster, 424,012, March 25.

Metallurgical:—Furnace, G. P. Denis, 422,189, February 25. *Magnetic Separator*, G. Conkling, 422,732, March 4. *Process of Electro Plating Non-Metallic Articles*, W. H. Winslow, 423,101, March 11. *Process of Separating Magnetic Particles*, G. Conkling, 423,907, March 25.

Metal Working:—*Method of Electrically Heating Bars, etc., for Welding and Working Purposes*, M. W. Dewey, 422,190, February 25. *Method of Electric Welding*, C. L. Coffin, 422,730, March 4. *Method of Welding Metals by Electricity*, same, 423,732, March 18. *Method of and Apparatus for Electric Welding*, same, 423,733. *Method of Welding Metals by Electricity*, same, 423,734 and 423,735. *Method of Welding Metals Electrically*, same, 423,736, March 18. *Method of Manufacturing Projectiles by Electric Welding*, W. M. Wood, 424,441. *Electric Forging Machine*, R. Ross, 423,956. *Method of Electric Soldering, Cementing*, etc., E. Thomson, 423,966. *Apparatus for Electric Soldering and Cementing*, same, 423,967, March 25.

Miscellaneous:—*Cut-Out*, G. A. Frei, 421,396. *Electro-Magnetic Valve Controller*, J. V. Stout, 421,449. *Apparatus for Heating Water and Generating Steam by Electricity*, same, 421,499. *Electric Lock*, W. Grah, Jr., 421,567. *Thermostat*, G. F. Bulem, 421,852, February 18. *Electric Switch*, W. E. Parker and H. E. Temple, 422,147. *Electric Lighting Device*, E. E. Flora and P. R. Hoy, 422,196. *Electrical Apparatus for Driving Artesian Wells*, G. G. Freyer, 422,201. *Electrically Propelled Vehicle*, J. Adair, 421,887, February 25. *Coin-Controlled Weighing and Strength-Testing Machine*, J. F. Bower, 422,876. *Inductorium*, A. H. Hoyt, 422,885. *Electro-Magnet*, R. Eickemeyer, 422,512. *Automatic Circuit Breaker*, M. C. Happoldt, 422,524, March 4. *System for Stopping Machines*, W. H. Kilbourn, 422,948. *Electric Valve Controller*, E. R. Malmborg, 422,956. *Electrically Controlled Elevator*, W. J. Paine, 422,968. *Casing for Electric or Other Apparatus*, L. S. Woodbury, 423,014. *Phonograph for Dolls or Other Toys*, T. A. Edison, 423,039. *Thermal Cut-Out*, J. J. Wood, 423,102. *Electric Heating Apparatus*, M. W. Dewey, 423,223. *Electric Shaft Controller*, A. W. Hart, 423,245. *Stationary Fire-Extinguishing Apparatus*, W. C. Smith, 423,286. *Coin Operated Electric Apparatus*, J. S. Wallace, 423,361. *Self-Destructive Torpedo Vessel*, S. Barton, 423,405, March 11. *Apparatus for Producing Steam, Heat and Light by Electricity*, T. D. Farrall, 423,421. *Electric Wire Molding*, J. A. Seely, 424,449. *Electric Switch*, G. H. Whittingham, 423,462. T. F. McEvoy, 423,488. *Coin Operated Display Apparatus*, E. H. Amet, 423,654. *Static Electrical Machine*, H. Tirmann, 423,708. *Lightning Arrester*, G. S. Maxwell, 423,788. *Switch for Electric Apparatus*, S. L. Barriett, 423,891, March 18, *Electric Valve Controller*, E. Thomson, 423,965. *Igniting Apparatus for Gas Engines*, E. F. Roberts, 424,027. *Electric Radiator*, H. R. Butterfield, 424,047. *Circuit-Closer*, J. A. Dempf, 424,182. *Thermostat*, W. F. Singer, 424,363. *Electric Stop-Motion for Knitting Machines*, J. P. Haslam, 424,295. *Electric Heating and Cooking Device*, H. R. Butterfield, 424,403. *Electric Flat Iron*, H. R. Butterfield and W. Mitchell, 424,404, March 25.

Railways and Appliances:-*Electric Railway Car*, H. C. Wirt, 421,464. *Switch for Systems of Electric Locomotion*, F. Wheeler, 421,535. *Support for Trolley Wires*, J. H. Cunningham, 421,677, February 18. *Electric Railway Motor Car*, C. J. Van Depoele, 422,266. *Electric Motor Car*, C. J. Van Depoele, 422,266. *Electric Motor Car*, I. H. Farnham, 422,339, February 25. *Supporting Frame for Electric Railway Motors*, E. Z. Priest, 422,445. *Electric Railway*, S. H. Short, 422,645. *Electromotor Engine*, S. Z. De Ferranti, 422,755, March 4. *Reversing Trolley*, H. P. Roberts, 422,976. *Overhead Electric System*, W. Vogler, 423,004. *Trolley Wire Supporting Apparatus*, same, 423,005. *Trolley for Overhead Electric Railways*, F. B. Rae, 423,391. *Electric Motor Car*, D. C. Voss, 423,400, March 11. *Electric Connection with Car Tracks*, G. G. Campbell, 423,468. *Electric Railway System*, L. Gutmann, 423,552. *Means for Supplying Electricity to Tram Cars*, A. L. Lineff, 423,874. March 18. *Electric Locomotive*, G. W. Mansfield, 424,070. *Electric Railway*, W. Thompson, 424,082. *Coupling for Trolley Wires*, S. Harris, 424,110. *Electric Railway Car*, R. M. Hunter, 424,206. *Electrically Propelled Vehicle*, same, 424,207. *Electric Railway*, J. C. Henry, 424,298. J. F. McLaughlin, 424,340P. E. P. Slentz and J. B. McGrew, 434,364. *Removable Truck for Electric Cars*, J. Stephenson, 424,371. *Electric Car Truck Frame*, same, 424,373. *Electric Car Truck*, same, 424,372. *Trolley Bridge*, same, 424,374. *Combined Conduit and Overhead System for Electric Railways*, C. J. Van Depoele, 424,380. *Trolley Arm for Electric Railway Cars*, same, 424,381. *Electric Railway Motor*, F. J. Sprague, 424,436, March 25.

Secondary Batteries:—*Electrode for Secondary Batteries*, H. H. Carpenter, 421,666, February 18. *Secondary Battery*, W. B. Hollingshead, 422,216. *Electrode for Secondary Batteries*, C. J. Hartmann, 422,301, *Electrode for Storage Batteries*, same, 422,300. *Electrode for Secondary Batteries*, F, M. Lyte, 422,306. *Secondary Battery Plate*, J. B. Entz and W. A. Phillips, 421,916, February 25. *Treatment of Storage Battery Plates*, C. Sorley, 422,457. *Secondary Battery*, S. C. C. Currie, 422,504 and 422,505, March 4. *Connecting Device for Battery Terminals*, R. N. Chamberlain and J. C. Chamberlain, 423,310. *Method of Preparing Active Material for Secondary Batteries*, C. Sorley, 423,091. *Secondary Battery*, W. A. Johnson and J. N. Smith, 423,324, March 11. H. W. Wardwell, 424,152, March 25.

Telegraphs:—*Railway Telegraph*, J. S. Foley, 421,394. *Machine for Turning Telegraph Pins*, W. W. McNeal, 421,654, February 18. *Telegraphy*, T. A. Edison, 422,072, 422,073 and 422,074, February 25. *Printing Telegraph Receiver*. H. Mahnken, 422,604, March 4. *Telegraphic Repeater*, S. S. Emery, 423,229, March 11. *Fire or Police Telegraph*, G. C. McCullough, 423,487, March 18. *Multiplex Synchronous Telegraph*, R. G. Brown, 423,901 and 423,902. *Synchronous Multiplex Telegraph*, same, 423,903. *Telegraphy*, C. Langdon-Davies, 424,006. *Quadruplex Relay*, F. W. Jones, 424,209, March 25.

Telephones and Appliances: *Telephone Switch*, E. C. Titus, 421,636. *Mouth-Piece for Telephones*, R. W. Whitney and B. K. Cowles, 421,800. *Flexible Electric Connection*, J. F. Wollensak, 421,802, February 18. *Telephone Line Vibrator*, H. W. Ladd, 422,082. *Grinding Electrodes for Microphones*, S. H. Bartlett and H. E. Waite, 422,174. *Switch-Box*, M. R. Muckle, Jr., and T. C. Smith, 422,244, February 25. *Apparatus for Speaking Telephones*, T. A. Edison, 422,577. *Telephone Repeater*, same, 422,578 and 422,579. *Automatic Telephone Call*, H. L. Carpenter, 422,722. *Telephone Switch System*, C. C. Gould, 422,765, March 4. *Ear-Phone for Telephones*, J. J. Wolf, 423,299, March 11. *Individual Telephone Call*, J. Sack, 423,575, March 18. *Multiple Switch Board*, M. G. Kellogg, 424,310, March 25.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

NEW THOMSON-HOUSTON ELECTRIC ROADS.

The Thomson-Houston Electric Co. has recently closed a contract with the Augusta, Hallowell & Gardiner Railway Co., of Augusta, Me., for three motor cars and an equipment of three miles of track. It is intended to operate this line between the above named cities, between which there is no means of communication now, except by the turnpike and the steam road. The construction work will be commenced as soon as the ground will permit setting poles, and it is expected to have it in operation early in the spring.

A contract has been closed by the Thomson-Houston International Co. with the Bremen Tramway Co., Bremen, Germany, for six motor cars, and two miles of electrical equipment.

The Citizens' Street Railway Co., of Indianapolis, Ind., has contracted for 6½ miles of equipment and ten motor cars.

A contract has also been closed at Pueblo, Col., with the Pueblo City railway for ten motor cars. The overhead construction will be used throughout on this line, which comprises a total of 21 miles of track.

A contract has also been closed at Port Townsend, Wash., with the Port Townsend Street Railway Co., for three cars. The line is three miles in length, and the overhead construction will be used.

The Rockford Street Railway Co. has also closed a contract for a line (overhead construction) of 6¾ miles in length and an equipment of seven motor cars.

The So. Bend & Mishawaka Street Railway Co. has closed a contract for an electric railway at So. Bend, Ind. The line will be eight miles in length (overhead construction) and six motor cars will be used.

A contract has been also closed with the Springfield City Railway Co., Springfield, Mass., for a line of two miles in length, on which six cars will be operated.

A contract has also been closed at Springfield, Ill., with the Springfield City Railway Co. for eight motor cars, and an equipment of seven miles of track, overhead system.

A contract has also been closed with the Toledo Elec. Railway Co., Toledo, O., for an additional equipment of seventeen miles of track, and twenty-five motor cars. There are already three motor cars in operation here, and 2½ miles of track have been equipped. With the additions the road will have twenty-eight motor cars, and 19½ miles of track electrically equipped.

The Winona City Street Railway Co., Winona, Minn., has also closed a contract for five motor cars, and four miles of track, and the Douglas County Street Railway Co. for the same length of track and two motor cars.

A contract has also been closed at Shreveport, La., for four motor cars, and four miles of track.

These contracts aggregate 114 motor cars, and 107.05 miles of track.

MORE ELECTRICAL MINING APPARATUS FOR THE TRANSVAAL.

We gave a description some time ago of a large installation for the electric transmission of power which was being manufactured by the Sprague Electric Railway and Motor Co. for the Forbes Reef Gold Mining Co., of the Transvaal, South Africa. This plant will transmit power from a waterfall, where are situated a number of Pelton wheels, to the mine premises, more than three miles away. The wires connecting the water wheel with the electric motors at the mine will be carried upon poles right across country in a direct line. The amount of power transmitted will be 140 h. p.

The Forbes Reef Co. are now so thoroughly satisfied that electricity is the most convenient and economical agent for transmitting power long distances, and applying it at its point of use, that the managers of that company have ordered additional apparatus, including dynamos and motors with wires for the transmission of 75 more horse power. This will make a total of 215 h. p. to be transmitted from the water power, which will be used on the mine premises. The efficiency of the whole electric system will be about 70 per cent.

When the long distance which the power is transmitted is taken into consideration this is indeed a remarkable record.

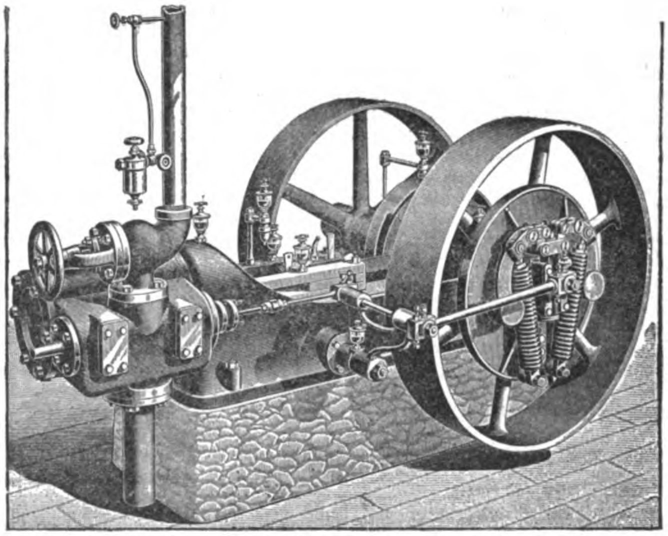
Part of this apparatus has already been shipped to the Transvaal, and the rest will follow soon. The construction and installation of this plant will be under the direction and supervision of Mr. Wm. Rydler, of the Sprague Electric Railway and Motor Co. When this is finished it will be one of the largest, if not the largest and most extensive, electric mining transmission plant in the world. While it is to be regretted that the managers of mines in this country have as yet not availed themselves to any very great extent of the advantages in the transmission of power by electricity, it will probably not be long before many of the water powers which now run to waste in a large number of mining localities will be utilized with advantage.

THE ERIE CITY AUTOMATIC CUT-OFF ENGINE FOR ELECTRIC LIGHTING.

There is probably no one factor whose influence has been greater on the design and construction of the steam-engine than the electric light, and the improvements which were inaugurated ten years ago in the high speed engine are still going on.

Among the engines which have been specially constructed for electric light service, and in which the rigorous conditions met with in that class of work are fulfilled, is that illustrated in the accompanying engraving. It is built by the Erie City Iron Works, of Erie, Pa. The engine is so constructed that the centre of the cylinder is in line with the centre of the crank shaft. The journals are well proportioned, and the bed at the crank end is wide, thus securing a broad surface bearing upon the foundation. The steam ports are short, and afford ready exit for the exhaust; they are covered by removable plates, thus allowing easy access for inspection.

The piston valve is perfectly balanced, and the valve stem is supported at the front end by the stuffing box, and at the back end by the back steam chest head, which has an outward extension for this purpose. This relieves the valve seat of the weight of the valve, and reduces the wear to a minimum amount. The crank shaft is cut from a solid forging, the counter balances are large in diameter, and all the bearings are well finished. The best form of connecting rod has been adopted and the boxes are strong and well babbitted; the crosshead is extra heavy, and the wings are spot babbitted. The bottom slides are independent of the bed and can be adjusted for wear. The piston is wide and packed with sprung rings, fitted and turned to give the best results. The valve stem is of steel, and the valve is properly adjusted when the engine is tested at the works. The governor is independent of the driving pulley, which is an important feature; it is simple in construction and has but few parts.



The Erie City Engine.

It will also be noted that the rocker arm operating the valve is connected to the governor outside of the fly-wheel. By this arrangement the eccentric is done away with and the fly-wheel is brought close to the main bearing, so that the constant tendency of the main shaft to bend and bind in the bearings with consequent heating is avoided.

The engine is substantially built throughout with interchangeable parts finished to templets, and it varies in size from 30 h. p., running at 300 revolutions per minute, to 125 h. p., running at 250 revolutions.

The Eastern Electric Light and Storage Battery Co. are meeting with so much success with the Sorley battery, that they are now looking around for suitable premises for the manufacture of these batteries. They are at present supplied by the Anglo-American Storage Battery Co., of New York.

EUREKA TEMPERED COPPER FOR ELECTRICAL WORK.

Copper enters so largely into the construction of electrical apparatus, especially under conditions where it is subject to wear that any means by which its life can be increased must prove of value. This is specially the case with commutator strips, brushes, switch contacts and the like, the renewal of which is a constant source of expense. In order to avoid this the Eureka Tempered Copper Co., of North East, Pa., have recently brought out a quality of copper which is tempered or toughened by a secret process, and by which its life is greatly increased without affecting in any way its conductivity.

This quality of copper is also well adapted for bearings and journal boxes for electric motors and dynamos, trolley wheels, cut-outs, etc., and in general for all surfaces subject to friction.

THE NEW YORK INSULATED WIRE CO.

The above concern, of 649–651 Broadway, are enjoying a large measure of prosperity, and have yet to find the limit of the field in which they are working so actively. Mr. J. Godfrey, has been in New Orleans lately, and has filed some large orders from that district. In Detroit he has established a new agency in the hands of the Fisher Electric Co., of that city, and the first order from that quarter mounted up into hundreds of thousands of feet.

The company have lately been engaged making up a carload of wires, cables, etc., for their Chicago agents, the Knapp Electrical Works, 54–56 Franklin street, that city.

Mr. George H. Meeker has been selected by Mr. Gallaher as Mr. Godfrey's assistant, so that the territory which has grown altogether beyond the ability of any one man to cover may be property looked after. Mr. Meeker will work along the lines so successfully laid down by his chief, and there is no doubt that his work will add to the company's reputation and revenues.

A recent order received by the company was for a Brush plant at Yokohama, Japan.

THE INTERIOR CONDUIT AND INSULATION CO.

A certificate of incorporation of the Interior Conduit and Insulation Co. was filed in the county clerk's office a few days ago. The objects of the company are to manufacture tubes for electrical wires. The capital is placed at $1,000,000. The trustees are E. H. Johnson, Sigmund Bergmann, John H. McClement, Edward T. Greenfield and Philip Klein. All these gentlemen are well known in connection with prosperous and progressive electrical enterprises, and the interior conduit has already in a most remarkably short space of time, made a splendid record in popularity and efficiency as a means of carrying wires of all classes into and throughout buildings of every class. The company is the successor of the Interior Electrical Conduit Co., which in a few months outran its extensive manufacturing facilities, and which now with larger capital and increased forces is going in for the work that awaits it. The new company will also do a large business in the supply of its special form of conduits for out-door, underground work, such, for example, as that in connection with the disposal of supply wires to electric railway lines, and the general work of electric distribution over a large area from central lighting and power stations.

THE CONTRACT OF THE STANDARD SUBWAY COMPANY HELD DEFECTIVE.

The General Term of the New York Supreme Court has reversed Judge Andrews's decision, and has renewed the injunction which prevents the Board of Electrical control from awarding the proposed subway contract to the Standard Subway Company. There were two suits, one by the Manhattan Electric Light Company and one by Taxpayer Armstrong. So far as the corporation's suit is concerned the General Term sustains Judge Andrews, but it holds that the taxpayer is entitled to an injunction. Armstrong's suit was brought to buttress the other.

The Court says that Armstrong had a right to sue, and that the main question is whether the contract he seeks to prevent is an illegal official act. The company holding the present contract says it cannot complete the work now ordered in less than two years. The Court continues:

"It has not refused to proceed with the work, but in consequence of an arrangement or understanding entered into with the Standard Electrical Subway Co. it proposes to surrender and assign all its rights and interests in certain portions of these contracts and the work it has already performed to the latter company, and to carry this arrangement or understanding into effect a contract has been proposed by the Standard and sanctioned by the city of New York, and whether this contract in this manner accepted is one which the acts already mentioned will allow to be executed and carried into effect is the more important part of the controversy now before the Court."

The opinion goes on to say that it was the purpose of the Board of Electrical Control, as expressed in its resolution of February 19, 1890, that the subways therein designated should be built within the year 1890. But the Court continues:

"This resolution has been made no part of the contract which it is proposed shall be entered into. Neither has the party with whom it is proposed to make the contract been in any manner obligated by its terms or its necessary implications either to construct the subways within the current year or in the streets and avenues mentioned in the resolution."

The proposed contract with the Standard company is defective. It does not provide that the company shall build such subways as the Board may direct it to build. It does not embrace the streets mentioned in the resolution of the Board of Electrical Control. The contract does not provide within what time the subways shall be built. The Board has gone beyond the power given it by statute in some of the provisions. While the city is empowered to purchase the subways after January 1, 1897, subject, nevertheless, to leases and mortgages, no provision is made to limit the amount of encumbrances the Standard company may put on the subways. The statute fixed the mortgage limit at 50 per cent. The Court says:

"The company, by the terms of the contract, would be enabled, by the placing of excessive mortgages upon the property, to prevent the city from becoming a purchaser.

"The proposed contract would leave it to the volition of the Standard company to construct subways or not, as it might afterward determine to be most expedient for its own interests.

"The plaintiff is in a position as taxpayer to prevent this illegal contract from being subscribed and completed, certainly until it shall be made entirely definite and clear that the rights of the public will be subserved and effectively secured."

THE BERGMANN ELECTRIC AND GAS FIXTURE COMPANY.

The above company, in their extensive factory at 527-537 West Thirty-fourth street, near the North River, have already built up a prosperous and progressive business, which keeps each of the seven stories humming like a hive. Not only is the fixture industry here developed to its fullest extent, but special attention is given to the construction of new forms of apparatus, either in single experimental sets or in large quantities; and altogether some 400 men are employed in the various departments. The fixture work is divided up into the foundry, iron work, dipping and depositing, chasing, modeling, brass spinning, glass working, buffing, lacquering, plating, assembling, shipping and other departments, in many of which old processes have been skillfully improved or new ones have been brought to perfection. Some fine work can be seen in hand at any time in the wrought-iron, brass spinning and chasing departments, and Mr. Bergmann has one or two artistic productions coming along that are likely to arouse very general interest and admiration. Some idea of the care bestowed on the details of glass work may be formed from the fact that when the writer squeezed his way through the crowded factory he found in that department one of the skilled heads of it putting together 300 pieces of special stained glass in a beautiful shade or globe for a leading railway magnate's house. On the electrical instrument floor, it may be mentioned, model apparatus is in hand all the time, and among the company's recent efforts for inventors have been new telegraphic apparatus, a new meter, and new arc lamps, of which they are now making a great number for direct commercial introduction. This is surely range enough. Mr. G. A. Scott, the electrician, is gradually getting together a neat testing outfit in his laboratory, so that he will have no difficulty in making the most delicate measurements as occasion arises.

The company have, of course, electric lights all through the factory, and run one of the big old Edison dynamos by a Watts-Campbell engine. It is worthy of note that the dynamo, which is one of Mr. Bergmann's pets, is doing as good work to-day as it ever did, with a commutator as smooth as glass or a maiden's cheek. The engine power is to be greatly increased to meet the growing demands of the factory.

In the front of the building the offices are located, on the ground floor. A full line of the company's handsome productions is carried at the show rooms, Fifth avenue, this city. At one or other place may be found in business hours, and hours when most business men have gone home to rest, Mr. Sigmund Bergmann, the president of the company, and a pioneer in electrical work; Mr. E. F. Caldwell, vice-president, well known for his skill and taste in design; and Mr. P. H. Klein, the secretary and treasurer, on whom devolves a large part of the conduct of the large business.

THE USE OF LIGHTNING RODS FOR STATIONS.

MR. J. D. WEST, of 40 Cortlandt street, who has long made a specialty of the lightning rod business, writes us a pertinent letter, as follows:

"In view of the frequent invasions of electrical stations by intensified electrical disturbances, would it not be a safeguard if the buildings containing such stations were properly covered on their outer angles with lightning rods of such construction as will freely receive and disperse throughout their entire circuit, and thus equalize the tension all about the building. The Mount Morris plant has such rods; would it not be well if others were thus protected?"

THE CROCKER-WHEELER ELECTRIC MOTOR CO.

The above company are in receipt of advices from their London agents, stating that they have secured the first prize for the Crocker-Wheeler motor at the Birmingham (England) International Exposition. The motors have been shown by comparative tests to have decided advantages in efficiency, durability, simplicity and design. Accompanying this gratifying information is an order for 14 motors, including fan outfits and electric pumps. Both facts are additional proof of the ready appreciation now being shown in England of American electrical apparatus of good workmanship and based on sound engineering principles.

The company have recently appointed Mr. T. McCoubray to the position of secretary and general agent, with offices for the present at the head-quarters, 322 and 324 7th avenue. Mr. McCoubray is well known as having held for a time the secretaryship of the National Electric Light Association. He was also connected later with the old Baxter motor company and was entrusted with the management of its New York office. He brings to his new duties a wide acquaintance and a ripe experience with motor work, as well on the engineering as on the commercial side.

THE "HELMET BRAND" WIRE.

The increasing demand for a good insulated wire at a lower price has led the Empire City Electric Co., of 15 Dey street, this city, to place upon the market a new wire under the trade-mark of the "Helmet Brand."

If the reputation of the company is at all a guarantee of the quality of the wire, it cannot fail to meet the requirements of consumers. It is being manufactured by the company in large quantities and is meeting with a ready sale.

With regard to the new products of the company, it is worth while quoting their own language. "Of the "O. E." weatherproof wire they say: "This wire is especially adapted for all kinds of line work and also for inside wiring where it is not necessary to use the highest grade of insulation. It has a hard smooth finish, does not soften or crack under extremes of temperature, is water-proof and able to withstand a great amount of abrasion. For tree-work and unusually damp places the insulative efficiency may be increased by additional braids. The covering consists of an insulation, a saturated braid, and a water-proof finish which also adds to the insulative qualities of the wire."

Respecting the "E. T." taped and braided wire they say: "This wire is essentially for line work, has a very high insulation and will withstand the action of the weather without deterioration. Being thoroughly water-proof and not affected by acids or gases, it is of especial service wherever a high grade of insulation is needed. The materials used in making this insulation are such that of necessity the wire is especially adapted to withstand abrasion and rough usage. The covering consists of an insulation, a saturated braid, two uncured rubber tapes wound in opposite directions, an insulation, a braid and a weather-proof finish. This is one of the best insulated wires ever offered to the trade."

Not satisfied with these new departures, the company promise to have other special grades ready at an early date.

THE TROPICAL AMERICAN TELEPHONE COMPANY.

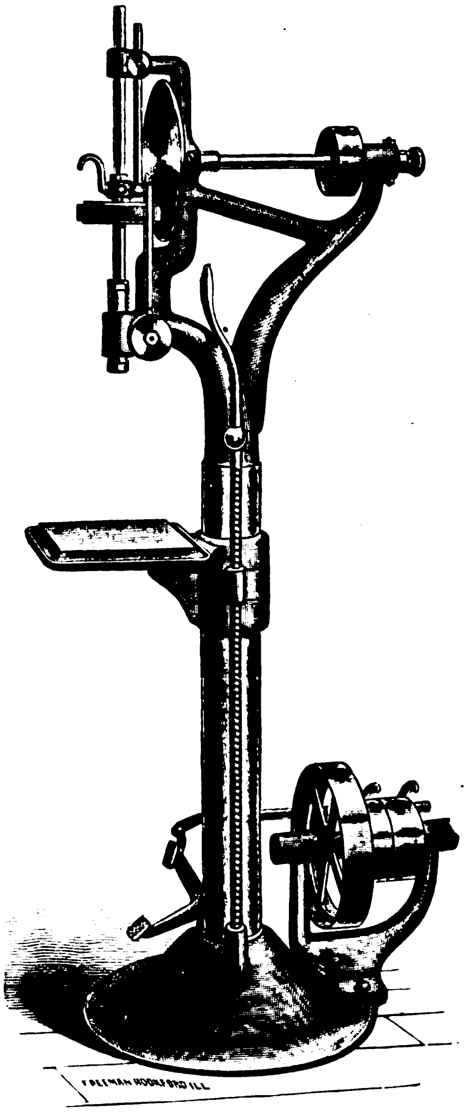
The export business to South America, Central America, and the West Indies in telephones, magnetos and telephonic apparatus of the Tropical American Telephone Co., of Boston, has increased so rapidly that it has necessitated the employment of a large corps of experienced men in the New York office and the establishment of branches in other cities. Mr. Frank W. Harrington, so long and favorably known as salesman for the Western Electric Co., of New York, has been induced to take charge of the Tropical American company's New York branch, and assumes his duties on April 1, to assist Mr. H. W. Bates, who has been in charge there since June 1889. Mr. Harrington's large experience in the telephone field will make his services very valuable. He was formerly with Mr. Charles Williams, Jr., when his large establishment at 109 Court street, Boston was known as the headquarters for the manufacture of telephones, transmitters, magneto call bells, switch boards, and telephonic apparatus and supplies, the Bell system of electrical devices having been built under his eye, and largely through his energy and inventive genius. Mr. Williams, who is said to be the largest individual stockholder in the Western Electric Co., is now President of the Tropical American Telephone Co., succeeding Colonel Henry S. Russell, who retired from active business some time ago. Mr. Harrington will now be located at 18 Cortlandt street, and exporters and commission merchants will find him ready at all times to furnish quotations for every kind of telephonic apparatus. The Tropical American company will soon issue a neat pamphlet setting out in full its telephonic rights in its territory.

CLARK ARC LAMP FOR CONTINUOUS INCANDESCENT CURRENT.

The Clark Electric Co., 192 Broadway, New York, have, it is claimed, the safest and most efficient arc lighting system in this country. The many new features invented by Mr. Clark, the electrician of the company, are exceedingly valuable. Among the latest are the Clark automatic safety device for high tension currents, for shunt-wound dynamos and alternating dynamos, and the Clark arc lamp for continuous incandescent currents. This lamp is being used for interior lighting in New York. The Columbia College authorities of this city have used it for over a year with perfect satisfaction. The illuminating power of the lamp is, it is asserted, the greatest of any arc lamp made. It is perfectly steady, and does not hiss or flicker, and is entirely noiseless. This supplies a long felt want where it has been found objectionable to operate arc lights indoors. It is well known that colors show the same by arc light as by daylight, and that the arc light is the cheapest illumination in the world, considering the cost of its production; hence, with the other essentials added, it proves irresistible.

THE NEW BARNES SENSITIVE DRILL.

THE sharp competition existing between manufacturers in all lines of electrical work makes it necessary for them to employ only the most perfect tools and machinery in order to produce their goods to the best possible advantage. This demand for improved machinery has stimulated the inventive faculties of our mechanics and engineers, with the result that new machines are being produced, which, considered in relation to their special adaptation for the purposes for which they were designed, are almost absolutely perfect.



The New "Barnes" Sensitive Drill.

As a case in point, attention is called to the new sensitive drill made by the W. F. & John Barnes Co., of Rockford, Ill. The drill is illustrated in the accompanying engraving, and it will at once be seen that the principles involved in its construction mark a departure from other tools of this kind.

The drill is adapted for use in the manufacture of electrical appliances, builders' and cabinet hardware, and, in general where the drilling is not large, but where delicate adjustment and rapid and effective operation are essential.

It is in the strictest sense of the word a *sensitive* drill, for the variations of speed and power are so completely under the control of the operator and the adjustments so perfect, that the person using the drill is always able to determine the pressure which is being applied. Herein lies the economy of this new tool in the preventing of the breakage of twist drills.

All the adjustments of power and speed can be made instantly without shifting belts or stopping the machine.

CONTROLLING DISTANT WATER GATES BY ELECTRIC MOTOR.

The displacement of steam-engines and other engines by the electric motor for general work has become so common an occurrence that it is now looked upon as a matter of course, and it is only the application of electric power to work which could not be done by any other means that elicits more than ordinary attention. A case in point is the movement and control of hydraulic gates at a distance of several miles from the point of operation. The Elektron Manufacturing Co. of Brooklyn have recently built two Perret motors for this purpose, one to be used at Marion, O., at a distance of three miles, and the other to be used at Decatur, Ala., at a distance of a mile or more from the operator. The dynamo used in each case is a small constant current machine. By changing the direction of the current at the dynamos, the motors, which are series wound, are run in either direction at will.

It is of course well known that with an ordinary series motor a change in the direction of the current on the line does not change the direction of rotation of the armature, because the current in both field and armature is reversed at the same time. In the case in point the reversal is effected by an ingenious automatic device invented by Mr. Frank A. Perret, the electrician of the Elektron Manufacturing Co.; this is attached to the motor and keeps the polarity of the fields unchanged regardless of change in direction of the current on the line, while the current in the armature, and consequently its direction of rotation, is reversed with each change in the main current. The water gates are thus controlled and placed in any desired position at the will of the operator, miles away, by simply turning a switch lever.

TALK OF "TRUSTS" AND COMBINATIONS.

The air has been, and continues, as thick as a sea fog with talk of trusts and combinations and new moves on the part of the larger electric light companies. One paragraph last week credited Mr. Henry Villard with a plan to form a big banking corporation to attend to the work of the Edison and allied interests. Another paragraph, which has done duty all over the country, is as follows:

"BOSTON, March 24.—Negotiations are in progress for the forming of an electric light and railway trust. The three great electric companies of the country are the Westinghouse, the Edison, and the Thomson-Houston. These companies control all the important patents for electric lights, both arc and incandescent, and for electric motors for street railways. The Thomson-Houston management proposed to the Edison people some time ago that the motor business of both companies be transferred to a new company, the profits of the new concern to be divided proportionately between the two. Later it was proposed that not only the motor interest, but the whole business of the two concerns be transferred to a trust. For this purpose, so it was stated to-day, all the large holders of Thomson-Houston stock have been asked to deposit their shares with five trustees, ex-Governor Ames and Messrs. Pevear, Duncan, Newhall and Sanford. Further, it is asserted that within two weeks overtures were made to George Westinghouse to have his company come in. His reply is not known, but "the street" has it that his acceptance is not unlikely. An electric light and railway trust could easily pay 10 per cent. on a capital of $50,000,000."

It is needless to say that some of this talk is mere wind, and that the rest of it is met with confirmatory denial or negative admission by those least interested.

SCHIEREN BELTING FOR ELECTRIC LIGHT PLANTS.—The house of Chas. A. Schieren & Co., 45–51 Ferry street, this city, have just secured a contract from the Louisiana Electric Light Co. of New Orleans, La., for 160 feet of 72-inch oak tanned double belt and 550 feet of 48-inch. It is stated that the 72-inch will be the largest belt ever furnished to an electric light plant, and will be the largest and heaviest belt in the world. It will be put together in the firm's new "Baby" hydraulic belt press. This "Baby" weighs 12 tons, is capable of making a belt 74 inches wide, and has a capacity of over 300 tons pressure. This order is a remarkable instance of the manner in which modern electric lighting makes a draft upon all the engineering and industrial resources of mechanics.

NEW UNITED STATES INCANDESCENT PLANTS.

MR. E. G. BERNARD, the well-known special agent of the United States, Sawyer-Man and Westinghouse Electric companies, reports a number of recent contracts and installations that he has made, including A. B. Morris, Amsterdam, N. Y., knit goods, 150 lights; Dun, Smith & Co., Fort Plain, N. Y., knit goods, 100 lights; Little Falls, N. Y. Paper Company, 50 lights; Standard Furniture Company, Herkimer, N. Y., 300 lights; Felts Falls Paper Company, Watertown, N. Y., 200 lights.

Mr. Bernard is, naturally, a little proud of his success among the knitting mills.

THE EDISON MACHINE WORKS.

The great Edison factories at Schenectady are reported to be busier than ever before, and vast extensions are to be made during the current year. When the plans have been fully carried out, the works will be twice their present size, and that point will probably be reached this summer. The force of men employed will also be greatly increased, and the total number will be 2,500 to 3,000. Activity prevails in every department, and much difficulty is experienced in keeping pace with orders. Mr. S. Insull, the manager, whose health broke down under the strain a few months ago, has just returned from England, whither he went for change and rest, thoroughly restored. During his stay abroad he took occasion to make close observation of work being done in London and on the Continent.

THE NEW FACTORY OF THE ANGLO-AMERICAN ELECTRIC LIGHT MANUFACTURING COMPANY.

The above-named company secured recently at a low price a very advantageous factory at Kensington, Conn. Mr. C. Sorley, its electrician and the inventor of its storage battery, has since been busily engaged laying out the premises in accordance with the new work and requirements. The old foundry building has been split up into five rooms, one 40x40 for powder preparation; one 118x40 for plate making, &c.; one 116x40 for charging; one 100x40 for the dynamos, with solid brick and cement foundations; one for boiler, etc. The factory also has a large water power plant of 200 h. p. New offices and warehouses have also been laid out.

The company has been giving out large orders for supplies, &c., and has contracted for eight Edison dynamos of 30 volts and 50 amperes each. The new factory will soon be in shape to do work on a very extensive scale. Mr. Bernard Lande, the general manager, has his headquarters at the company's office in the Times Building, this city.

TRADE NOTES.

THE WAINWRIGHT MANUFACTURING COMPANY, of Boston, have received an order from the Detroit Electric Light Company for a 300 h. p. heater.

OKONITE.—The new factory of the Okonite company located at Dundee, N. J., is completed, and the makers of Okonite wires and cables are exceedingly busy filling orders for these popular goods. There is a brisk demand for the Candee aerial wire also.

BERGMANN & CO., of East 17th street and Avenue B, are extremely busy in all their departments, and are filling some heavy fixtures and supply contracts. They have recently made some new departures in artistic electro-metal work, and the results are very creditable to their enterprise and taste.

THE NEW YORK BELTING AND PACKING CO., with headquarters at 15 Park Row, this city, manufacturers of vulcanized rubber goods for mechanical purposes, find a steady call for their well-known wares. They make a superior quality of belting for use on dynamos and other swift running machinery, which is attracting attention in electrical circles.

THE GOULD & WATSON COMPANY, of Boston, continue to receive large orders for moulded mica insulators for line construction work for all systems from all over the country. They are now making a specialty of a non-combustible insulation for switches, cut-outs, rosettes, etc., which have received the endorsement of the Boston Fire Underwriters' Union. Several important orders have recently been received from England for small insulating pieces for street and trolley line work, chiefly to be used in European countries.

THE WESTON ELECTRICAL INSTRUMENT CO., of Newark, N. J., are full of business. The Weston standard voltmeters and ammeters made by them have now been in use for over a year and in every case have givn entire satisfaction. Dr. Edward Tatum, of Philadelphia, in writing to the manufacturers, under date of August 17, 1889, says: " * * * I regard your voltmeter quite without a rival, as a combination in one instrument of the following qualities: extent of range with the great convenience of strict proportionality; complete absence of friction; quite new of action; accuracy throughout the scale."

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

New England Editor and Manager, A. C. SHAW, Boston, Mass.
Western Manager, W. F. COLLINS, Chicago, Ill

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. IX. NEW YORK, APRIL 9, 1890. No. 101

The advance of science is not in simple proportion to the time; the next fifty years will probably see a far greater advance than the one hundred years since the date of Franklin's electrical work has seen.—Professor John Trowbridge.

EXTENSIVE ELECTRIC RAILWAY WORK.

WHEN the winter now ending set in it was hardly expected that the mildness of the season would permit a very great activity in electric street railway work. But it may be doubted whether at any one time the companies putting in roads were able to catch up with the contracts, and now, as spring opens, it finds them not only with heavy orders in hand, but with a promise of new work that must far transcend the most sanguine forecasts of everyone concerned. While there are a large number of new roads to be built, of moderate size, attention and interest naturally centre in some of the leading cities. St. Louis, for example, will have at least eight or nine electric roads building this spring, the city authorities having been liberal in their concession of franchises. The work in St. Paul and Minneapolis is alone enough to occupy the energies of nearly all the men in the country familiar with the details, as engineers or laborers. In Rochester a contract has just been closed for 50 miles of track and 100 cars. In Pittsburgh several of the roads intend to adopt electric traction, and the Duquesne company has already contracted for 100 Pullman cars. Among other cities that may be mentioned as adopting the new mode of urban travel are Memphis, Atlanta and Chattanooga.

Evidently the construction of these roads will call for the expenditure of many million dollars, with a corresponding stimulus to electrical manufacturing and supply industries. It is to be feared that in some instances the rush and pressure will lead to bad work. This is specially to be deprecated and avoided. We know of no class of construction in which cheapness and poorness of skill and material lead more quickly to disastrous results than the electrical, just as there is none in which honest workmanship makes itself more quickly apparent.

THE PARIS METER COMPETITION.

WHEN, about one year ago, the city of Paris announced its intention of awarding a prize of 10,000 francs to the meter best adapted to its wants, it was supposed that the competition thus brought about would result in a definite selection. It was pointed out at the time, however, that the clause in the conditions of the contest giving the city of Paris the right to use the successful meter without further payment of royalty would prevent the entrance of many inventors, and this has, to some extent, been the case, as admitted by the commission appointed to adjudge the award. Nevertheless, all the more prominent meters employed in Europe, together with a few of American origin, were entered, with the result detailed more fully elsewhere. None was found to fulfill entirely the required conditions. Considering the great strides that have been made in all electrical branches during the last 10 years, it cannot but be considered a matter of surprise that thus far no device has been forthcoming which is able to satisfy the Paris Municipal Commission. Recognizing the undoubted value of some of the meters submitted, however, the commission have awarded various sums of money as an *encouragement* to their inventors. Taking into consideration the short time given to inventors to prepare for the test, as well as the restrictive clause relative to forfeiture of royalty to the city of Paris, the municipality has decided to open another competition from which these features are eliminated. We hope that American inventors will be more numerously represented in this second competition than they were at the last, and that they will more nearly conform to the conditions laid down by the commission. The faith of the commission in the ability of electrical inventors to provide an adequate meter is highly flattering.

Electric Railway Traction.

EARLY in the practice of electric traction, the phenomenon was observed, and probably first by Mr. Leo Daft, that the tractive power of the electric car was increased by the action of the current passing between wheel and rail. The exact nature of the phenomenon, which has been ascribed more particularly to a temporary welding action, has not yet been arrived at, nor have any systematic experiments to determine the extent of the action been published hitherto. Our readers will, therefore, be interested in the article by Mr. O. T. Crosby, in which he gives the results of a series of tests to determine the influence of this phenomenon on street-car traction. The conclusions arrived at by Mr. Crosby are negative, and would go to deny the assertion that any action takes place. Mr. Crosby admits that his experiments lacked somewhat in delicacy, but cites in support of the results obtained by him the fact that electric railways with overhead metallic return, and hence without current between wheel and rail, are able to mount quite as heavy grades as those in which the earth and rail are so employed. It will be noted, however, that all of these experiments were made with the car stationary, so that there was no means of ascertaining the effect of the supposed action with the wheels in normal rolling motion. While, in the absence of data, it might be difficult to predicate a difference in the results obtained, it would certainly be of value to determine this point under the conditions indicated; and we hope Mr. Crosby will continue his investigation in this direction. Incidentally, also, Mr. Crosby draws attention to a fact of some importance, which involves the question of economy as well as safety in operation, and that is that frequently far more current is applied to the motor at starting than is required for the purpose. The remedy for this is obvious.

Alternating Current Phenomena.

THOSE who had the pleasure of listening to Professor Thomson's admirable Institute lecture, of which we give an abstract elsewhere, could not but have been convinced that the alternating current opens up a vast field of new electrical applications. By the aid of our simple illustrations, sketched during the lecture, the reader will be able to gain at least a fair conception of the beauty and variety of Professor Thomson's experiments, carried out with that ease and in the convincing manner for which the distinguished author is so justly celebrated. One cannot suppress the thought that notwithstanding the extent of the phenomena and of their application thus revealed by Professor Thomson, he and others may be expected to develop many more of no less interest and practical value at no distant future.

Secondary, Primary and Storage Batteries.

WHILE the electrical units, based on physical constants, are now thoroughly defined and can give rise to no ambiguity, there are still a number of terms used in the science and art of electricity that require closer definition and restriction. This was perhaps most forcibly illustrated in the recent storage battery litigation, where much ingenuity was applied, and we had almost said wasted, in attempting to define the similarity, or difference, between the primary and the secondary battery. Leaving out the question of the appropriateness of the term "storage battery," which is objected to by some as unscientific, Mr. E. R. Knowles, in discussing the terms, finds each of them to be capable of distinct definition, and seems to make a fitting place for the term "storage battery or accumulator" in electrical nomenclature.

Municipal Control of Lighting Plants.

SOME interesting figures appear in this issue from Mr. Victor Rosewater, of Johns Hopkins, intended to show that it is cheaper for municipalities to make their own electric light than for them to buy it; and hence, that it is proper for them to instal and operate their own plants. Mr. Rosewater has been at some trouble to collate his figures, but they are neither complete nor conclusive. They should include, for instance, a distinction between steam power and water power plants, or the relative distances from coal supply, and the different costs of fuel. The argument for municipal control made is also weakened by the absence of any allowance on the score of taxation. A local company would bear its share of taxation in more ways than one, but a municipal plant simply shifts an extra burden to the taxpayer who is already charged with heavier taxation in order to meet the interest on the bonds, or on the other indebtedness of the community incurred in order to put the plant in. Then it is an altogether wrong assumption that lights should be cheaper in a city than in a small place, because more of them are rented from a company. A city plant pays higher rent, higher salaries, higher taxes, and is at vastly more expense than a rural plant in running its circuits, whether overhead or underground. There are other points that arise, but enough has been said to show that Mr. Rosewater's figures will stand revision as a basis for argument, or as a reason for the diversion of taxation.

The Electrical Demand for Copper.

ONE of the principal items entering into the manufacture of electrical apparatus and goods is copper. Perhaps a better appreciatian than generally obtains of this fact may be formed from the statement which we heard last week, and is true, that one of the large companies had just placed an order for 1,000,000 pounds of copper, and had at that time an order in for 250,000 pounds more. Enormous as this quantity may seem, it is understood that it will all be used up by July 1. The activity prevailing may readily be inferred from these figures, which are those of a single concern, though, of course, it is one of the most prominent.

Tests of Incandescent Lamps.

IN our last issue we brought to a close the articles by Mr. Puffer on the efficiency tests of various incandescent lamps, in which the author pointed out again in a forcible manner the discrepancy which exists in the illuminating power of the "16-candle power" lamps of various manufacturers. Though worthy of remark and, we hope, open to remedy, the difference here observed is not nearly so great as might be found in comparing the illuminating power of what is sold as "20-candle gas." Mr. Puffer quite correctly lays stress upon the fact that the value of an incandescent lamp ought not to be judged from the results of a few hours' burning, and it is therefore all the more to be hoped that his work will soon be sufficiently advanced to include a "life test" with continuous measurements of illuminating power at consecutive intervals. The results of such a test, combined with Mr. Puffer's method of combined efficiencies, would afford an interesting comparison with the Franklin Institute tests of 1884.

Greatness in Small Things.

THE field of application for the small electric motor is so vast that the construction of these machines was begun some time before the larger motors were thought to be sufficiently far advanced to warrant their practical application. But in the haste to perfect the larger, the smaller prototype lost ground, comparatively, again, and has until recently been very much neglected. Now, however, that the proper attention is being given to the subject, results are obtained which place these pigmies almost, if not quite, on a level with their more powerful brothers in point of economy. The means by which this gradual evolution has been accomplished are well described in this issue by Mr. F. B. Crocker, who shows that by studying and analyzing each element of construction and source of loss a result may be arrived at which places these machines easily in the front rank of prime movers.

ARTICLES.

CARE IN MOTOR TESTING.

BY FRANCIS B. CROCKER.

The development of the electric motor has been so very rapid that there has been but little generosity shown in giving care and time to its construction. From the moment of the first conception of a motor till it is finally put into use, every step in its production has been characterized by a haste that it would be difficult to find anywhere equaled, except perhaps in a fire engine station just after an alarm has been sounded.

The testing of electric motors has suffered more from this haste than any other department of the work, the idea being that it is only necessary to build a motor in order to sell it, while the testing can be replaced by hope that the motor may work properly.

We have passed, however, the period of this excessive haste and we should now give the most careful attention to each detail of electric motor design, construction and testing.

In connection with motor testing, Dr. S. S. Wheeler and the writer have recently gotten up several methods to facilitate and perfect this work.

We have had tables prepared giving the electrical horsepower for each volt and ampere from zero to the ordinary limits of practice; horse-power at the different speeds and torques; and current required to run motors of different power at various efficiencies. By these tables we can translate our results instantly without interrupting our work. If it is necessary to stop and go through a long calculation, the results lose their force. These tables must be complete and give each unit and fractions if possible; a table which skips by fives or tens is practically useless. We use also a test sheet which is much more complete than those generally used, giving over one hundred of the principal facts about a motor, and we find that we are able to detect and trace the cause of the smallest differences between motors by comparing their test sheets.

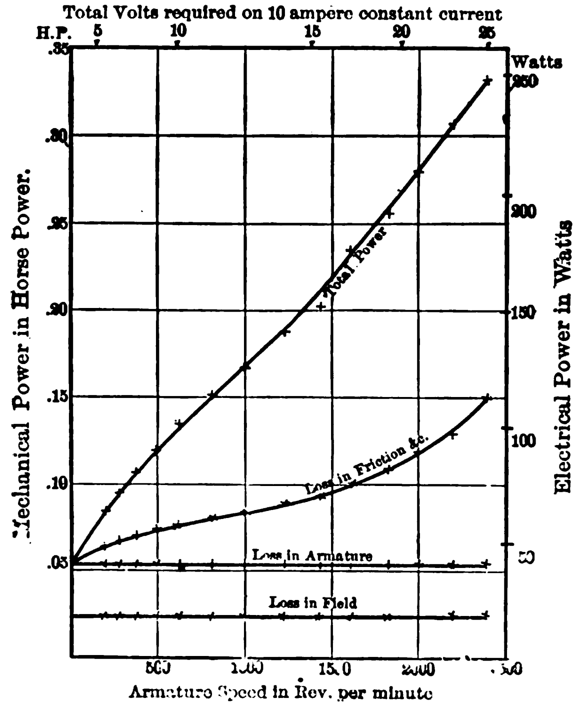


FIG. 1.

Another very useful aid employed by us in our work consists of a sheet ruled into squares, as commonly used for tracing curves, but made of convenient and uniform size with blank columns for observations on the side.

The use of this "curve sheet" is illustrated in the two accompanying diagrams. The first, Fig. 1, shows the results of a test on a small (1-8 h. p.) motor series wound for a 10 ampere constant current arc circuit. The abscissæ or horizontal distances represent the armature speed in revolutions per minute, and the ordinates, or vertical distances on the left, represent power in horse-power. At the top the volts corresponding to different speeds, and at the right hand side the electrical power in watts, are also given for comparison. The vertical distances between the axis and the lower horizontal line marked "loss in field" represent the electrical energy ($C^2 R$) consumed in the field, which is constant because the current and resistance are both constant. The distances between this line and the next line, marked "loss in armature," represent the energy lost in the armature resistance, which is also constant for similar reasons.

The upper inclined line represents the total electrical power supplied to motors at different speeds. This is equal at zero speed simply to the loss due to armature and field resistance, about .05 h. p., and increases almost uniformly to .335 h. p. at 2,400 revolutions per minute. The power actually developed by the motor at different speeds, as measured by Prony brake, is then laid off downward from the upper line, giving us another inclined line; the vertical distances between these two lines, therefore, show the net power produced at any given speed. The total vertical distances between the lower inclined line and the axis show the total losses in the motor, and the two horizontal lines show the losses due to armature and field resistances. Thus the vertical distances between the upper horizontal line and the lower inclined line represent all other losses, which are principally friction and Foucault currents. The rapid rise of these latter losses at high speeds is the most noticeable feature of the diagram.

The diagram, Fig. 2, illustrates a similar diagram made from tests of a 1-6 h. p. shunt wound motor on a constant potential circuit (110 volts). The striking analogies as well as differences between the two cases are quite interesting.

The present diagram, like the previous one, is plotted primarily with respect to power and speed, the vertical distances representing power in horse-power and the horizontal distances representing speed in revolutions per minute. At the right hand side the power is also given in watts, and at the top the total current consumed is given in amperes. In this way the relation between the various quantities is very clearly shown.

The vertical distances between the different curves represent the energy consumed in each case. For example, the energy consumed in the armature at 2,000 revolutions is measured by the vertical distance between curves A and B on the line through 2,000 revolutions.

The shunt machine in this diagram of course shows a constant consumption of energy in the field, which was also the case with the series machine, since both machines have a constant field resistance and are fed with either constant current or constant potential; therefore the loss due to resistance ($C^2 R$) is constant. The shunt machine shows, however, a variable loss in the armature, which is not the case with the series machine. This variable loss in the armature is due to variations in current caused by changes in speed and, therefore, changes in counter E. M. F. This loss in the armature increases more and more rapidly with increase of current, since it varies as the square of the latter. This armature loss is, of course, greater at the lower speeds because the counter E. M. F. is then less and the current correspondingly greater. The extremely small loss in the armature at the high speeds is remarkable; even at 2,000 revolutions, when the motor is actually developing 1-8 h. p., the energy lost in the armature is only 10 watts, about 6 per cent. of the total energy consumed, which is very low in such a small machine.

When the motor is loaded to its full capacity at 1,800 revolutions, and is then developing 1-6 h. p., the loss in the armature due to resistance is 20 watts. This increased loss is much greater than the increase of power developed because, as already stated, the former varies as the square, and the latter only as the first power, of the current.

The armature resistance loss at full load, 20 watts, is almost equal to the loss in the field, which is 27 watts. The general rule is that the two should be about equal at full load, but it is preferable to have the armature less as it runs at more constant speed if it is of low resistance.

The vertical distances between the two curves B and C represent the sum of the losses in the motor due to friction, Foucault currents and resistance of air. It will be noticed that these losses are practically constant from 1,800 to 2,000 revolutions, having a value of about 22 watts or .03 h. p. Above 2,000 revolutions the loss increases quite rapidly and becomes almost 50 watts at 2,250 revolutions, the speed at which the motor runs free. This increase in these losses at high speeds might be expected, and is shown in the diagram to be very marked.

It will be noticed that the three kinds of loss, *i. e.*, field resistance, armature resistance, and that due to friction and Foucault currents, are almost exactly equal to one another at 1,800 revolutions when the motor gives its full power. This uniform distribution of loss is very satisfactory because it tends to produce uniform action of the machine, and it indicates, moreover, that there is no one cause of loss which is excessive. It is very obvious that if any one part of the machine, the armature coils, for instance, produced any abnormal loss, they would be heated to a very objectionable degree.

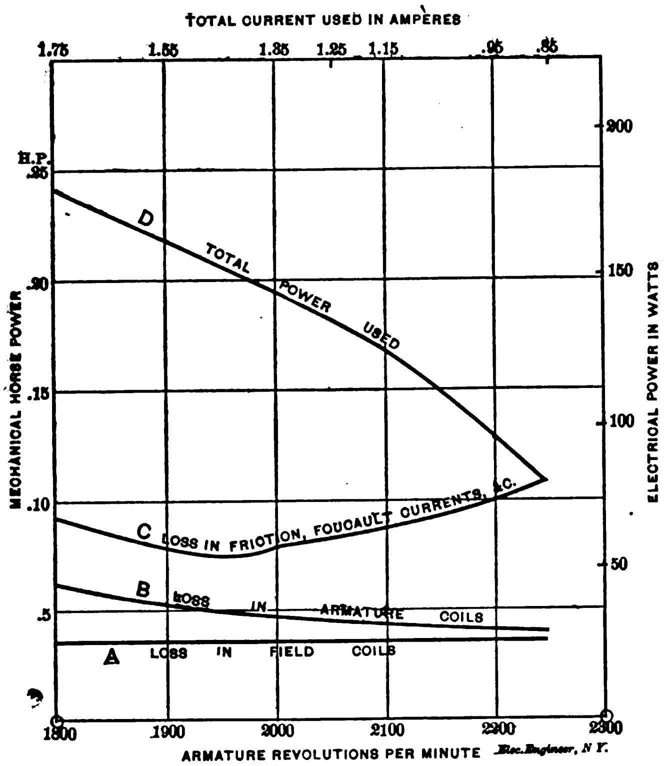


FIG. 2.

The useful power of the motor is represented by the vertical distance between the lines C and D; this power is, of course zero when the machine is running free at 2,250 revolu,tions, and is a maximum of 1-6 h. p. at 1,800 revolutions. This useful power, it will be seen, forms a large part of the total power consumed; in other words, the actual efficiency is high, being 62 1-2 per cent. at 1,900 revolutions when developing over 1-8 h. p.

These figures are good for a small motor, though, of course, 5 or 10 h. p. motors will run up to 90 per cent. efficiency with all the losses correspondingly reduced. In this connection we have only to consider what a very low efficiency a 1-8 h. p. steam, gas, or hot-air engine would be likely to give in order to see the very great advantages the small electric motor has over any other small engine.

DOES CURRENT BETWEEN WHEEL AND RAIL INCREASE TRACTION?

BY O. T. CROSBY.

We have not infrequently seen in print and heard in conversation the statement that in electric railways, working on a grounded circuit, there is an increase in the adhesion coefficient over that obtained in steam propulsion, due to the passage of the current through the wheels. To obtain some light on this subject the following experiments were made:

The car used was fitted with two motors of the second type made by the Sprague company. Its total weight was 10,900 lbs. The rail was of the tram type, and, though rusty, was reasonably free from dirt. The wheels showed tires in ordinary service condition. In such case the ordinary coefficients would show a possible tractive effort, before skidding, of 2,500 to 3,500 pounds. As this would have required currents greater than I cared to use, and would, moreover, have exceeded the capacity of the dynamometer at hand, it was determined to skid only one pair of wheels, and to relieve these of a part of their weight. One end of the car was, therefore, jacked up until the springs were almost, or wholly, relieved. This made it impossible to get dynamometer and current readings simultaneously, as had been desired. However, the ammeter and dynamometer were separately compared.

The currents necessary to produce skidding were first observed when the ordinary connection to ground, *i.e.*, through the metal of the motors, truck, wheels and rail, was in position. The connection was then changed, the ground wire being taken directly to the rail, at a point near the grounded terminal of the dynamo. The wheels were thus out of circuit.

As the first position to which the controlling switch can be thrown admits a current of about 50 amperes (one motor in circuit), a graduated resistance was improvised by putting a soldering iron and a tin plate in circuit; these were approached to, or separated from, each other through a tub of water, in the bottom of which lay the tin plate.

The control thus obtained was somewhat irregular, but answered the purpose. The current could be taken up quite regularly from 0 to about 20 amperes; from that value it frequently jumped to about 42 amperes. In such case the wheels always started to skid, whether ground was made through the wheels or directly to rail. When the current could be made to approach 42 amperes through a better gradation, as with intermediate values of 30, 34, 36 amperes, the skidding did not occur until a higher reading was reached—up to 50 amperes. When the jump was considerable, skidding occurred at even lower values than 42 amperes, as is shown in the accompanying table:

Wheels in Circuit.

(1.)	Current.—0	12	16	37..	Here	wheels skidded.
(2.)	“ 0	12	14	37..	“	“
(3.)	“ 0	14	16	40..	“	“
(4.)	“ 0	12	16	42..	“	“
(5.)	“ 0	10	12	42..	“	“
(6.)	“ 0	25	16	40..	“	“

Similar records, up to 12 in number were obtained.

Wheels out of Circuit.

(1.)	Current—0	12	31	16	42..	Here	wheels skidded.
(2.)	“ 0	14	16	18	42..	“	“
(3.)	“ 0	15	34	40	39..	“	did not skid.
(4.)	“ 0	15	42	40	35..	“	“ “

In the last case (4) the rise from 15 amperes to 42 was not as sudden as indicated in the table, though too quick for the recorder to get clear differences. A number of similar trials was made, to the number of fifteen or twenty. In one case of gradual approach up to 40 amperes, without movement of wheels, the controlling switch was thrown into a position giving less resistance in the field; the current rose to 52 amperes, and the skidding began quite vigorously. The change in position of the switch, the current values being such as are here considered, has little effect on the strength of field produced by the three field-coils, the arrangement of which is changed by the switch-movement; saturation having been reached for any arrangement produced by the switch, at lower currents than the effective values, as shown above.

While the sudden current changes might conceal the particular value just sufficient to produce skidding, the existence of the values, 34 and 25 in the tables above, shows that 37 amperes is about the lowest value, if approached with some gradation, that could produce skidding. This is further shown by this record:

Wheels out of Circuit.

Current.—	0	10	15	23	24	25..No skidding.
"	0	12	15	22	20	23.. "

A general conclusion may be stated—that, while the test was not delicate enough to prove that *absolutely no difference* of adhesion exists in the two cases, yet the difference, if it exists, is not worth considering.

Aside from this test, I may say that with nearly the whole of the experience of the Sprague company to refer to, I can recall nothing which refutes the conclusion here drawn. Furthermore, it is to be remembered that up to date the double metallic systems have climbed as steep grades as the grounded systems. In making these experiments it was noted that the slack of the gearing was taken up at from 5 to 10 amperes. When freed from the supporting chocks, the car started at from 10 to 20 amperes, the needle moving so quickly as to prevent accurate reading. When started by man-power, exerted through a dynamometer, the record shows 175 to 210 lbs. pull, varying with slight irregularities in the track (called level, but varying slightly in grade and condition of surface.)

Correspondingly, when the car was held fast by a chain, the dynamometer in the line of pull, a steady current of 14 amperes through the motor produced a reading of 175 lbs. on the dynamometer, showing the true starting current to have been about 15 amperes. As this occurred when the current passed through the wheels, it again shows that there is no appreciable resistance to wheel movement, either as to skidding or rolling on the rail, produced by the passage of the current.

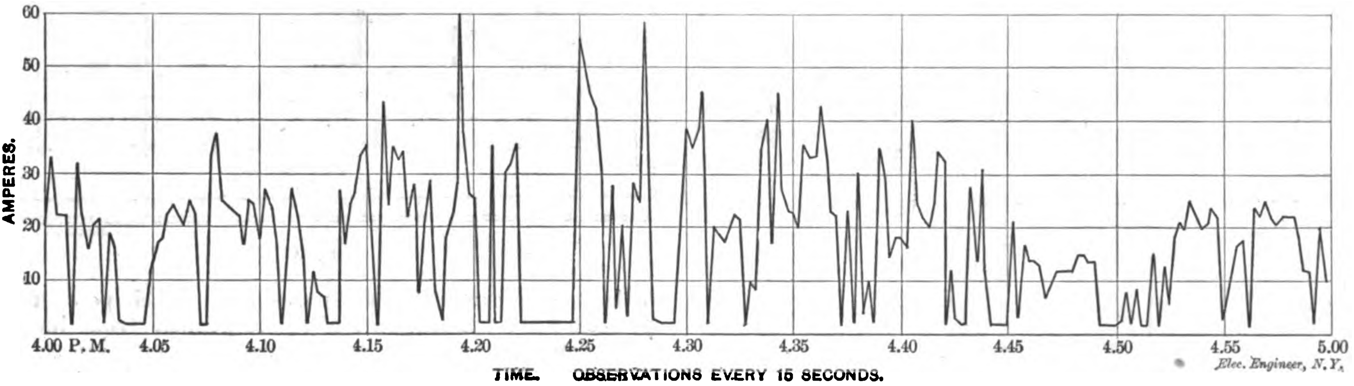
It is to be remembered that the momentary starting current, as shown by an ammeter, is a function, not only of the actual torsional effect required in the motor, but of the total resistance which it has pleased the manufacturers to insert in the motor circuit. Unless controlled, as was here the case, this initial current may, therefore, be greater than *just enough* to start the car.

The writer is indebted to Mr. Offut, superintendent of the Brooklyn and Jamaica Electric Railway, for the use of a car in making these trials.

.... Explanation always progresses by stages; no explanation is ultimate; every explanation is a step up, a removal of a thing from a lower to a higher category.—*Oliver J. Lodge.*

A TYPICAL RAILROAD AMMETER CURVE.

It is evident that in the operation of an electric railway with a large number of cars on the road at one time, there will be frequent stops and starts resulting in a considerable fluctuation of the current on the line. This characteristic has often been commented on but is most forcibly brought out by a glance at a curve representing the readings of the ammeter at the power station. We therefore present to our readers such a curve in the accompanying diagram which records the ammeter reading at the power station of the Sprague electric railway at Brockton, Mass. The curve gives the record for three cars on the road, and brings out very strongly the severe conditions which are met with in this kind of work.



A Typical Railroad Ammeter Curve.

SECONDARY, PRIMARY AND STORAGE BATTERIES.

BY E. R. KNOWLES, C. E.

In all the discussions which have taken place of late, there has been a great deal of ambiguity in the use of the above terms, especially in that of "secondary battery" as applied to storage batteries or accumulators, and it is proposed in this article to attempt to clearly define the difference in the meaning of these terms, from an electrical standpoint.

Looking at the subject of galvanic batteries as a whole, we find a great many kinds of batteries performing a great variety of functions. We have batteries composed of certain substances combined in certain ways, which, when they are put together, are ready, *at once*, without any further preparation, to give off electrical manifestations These are generally known as primary batteries. Some of these when exhausted, can be regenerated by sending through them a current of electricity from some external source. These may properly be called "storage batteries" or "accumulators." Some are not susceptible of any regeneration after once being exhausted and these may properly be called "primary batteries," pure and simple.

Again, we find batteries composed of certain substances combined in certain ways, which are inert in themselves and incapable of giving off any electrical manifestations until further prepared by being acted upon by a current of electricity from some external source. These may properly be called "secondary batteries." They are also, almost invariably "storage batteries" or "accumulators."

Thus we see that we have primary batteries which may, or may not, be storage batteries or accumulators, and we have secondary batteries which are never primary batteries, but almost invariably storage batteries or accumulators; and, conversely, we have storage batteries which may be either primary or secondary batteries.

The writer has ventured to give three definitions, which may help to keep these three great classes of batteries clearly defined and in their proper places, as follows:—

A secondary battery is one which is *inert in itself* and only becomes active to give off electrical manifestations *after* being acted upon by a current of electricity from some external source.

A primary battery is one which is *active in itself* and will give off electrical manifestations *without* being acted upon by a current of electricity from some external source.

A storage battery or accumulator is *any combination*, which will give off electrical manifestations, either before or after being acted upon by a current of electricity from some external source, and which, when it is *exhausted can be renewed or regenerated* by the action upon it of a current of electricity from some external source.

THE NEW WESTINGHOUSE LIGHTNING ARRESTER.

Of the numerous accessory appliances which go to make up a complete system of electric lighting, few have demanded stricter attention and seen greater modifications than the one intended to protect the machine and station apparatus generally from the effects of lightning. The first attempts in this direction copied closely the methods generally adopted for the protection of telegraph and telephone instruments, and consisted of the well-known pair of serrated plates separated by an air space, one connected to ground and the other to the line. When applied to electric lighting, especially high tension circuits, this device was found to be useful only when no current was on the wire; but if the lines happened to be struck during lighting time, with current on the wire, it was soon discovered that the arc formed across the serrated plates by the jumping of lightning charges was maintained by the current generated by the machine. This frequently destroyed the arrester, and also subjected the generators to the liability of a short circuit through the ground.

To avoid this continuance of the arc by the main current, numerous devices have been invented, among them a variety of mechanical contrivances by which, on the passing of a lightning charge, the arrester plates are separated a distance sufficient to break the arc. In another ingenious device of this nature, the arc is blown out by the well-known action of a magnet placed in close proximity to it.

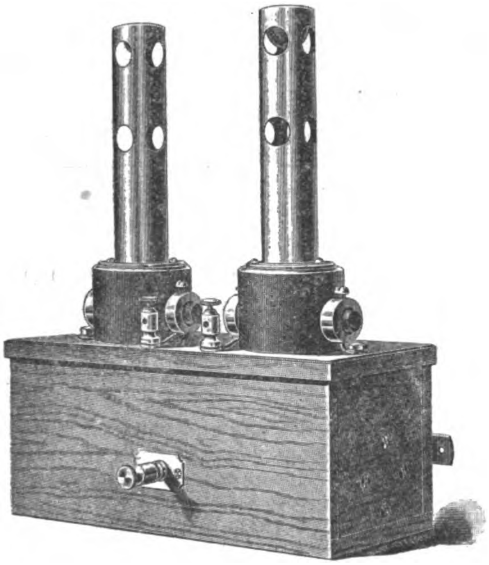


Fig. 1.

That the field in this direction has not been exhausted is evidenced by the fact that still another form of lightning arrester of an exceedingly ingenious nature has been brought out by the Westinghouse Electric Co., the design of which is due to Mr. A. Wurtz. In this apparatus, which is shown in perspective in the accompanying engraving, Fig. 1, the arc may be said to blow itself out.

This will be readily understood by an explanation of the construction of the apparatus which is shown in section in Fig. 2. Here, *a* and *a'* are air chambers separated by a partition. From each air chamber there is a slotted passage *c* and *c'* leading into the tubes *d* and *d'*, the top of each of which is provided with a rubber humper. *e e'*, *f f'*, *h h'*, *i i'*, are ordinary arc light carbons, and *j j'* are carbon balls bridging over the air spaces *k k'*. Each pole of the dynamo has a connection B B' to the ground from its respective binding post on the arrester through *e* or *e'*, *j* or *j'*, *f* or *f'*, *h* or *h'*, the jumping space *l* or *l'*, and thence by *i* or *i'* to the ground binding post.

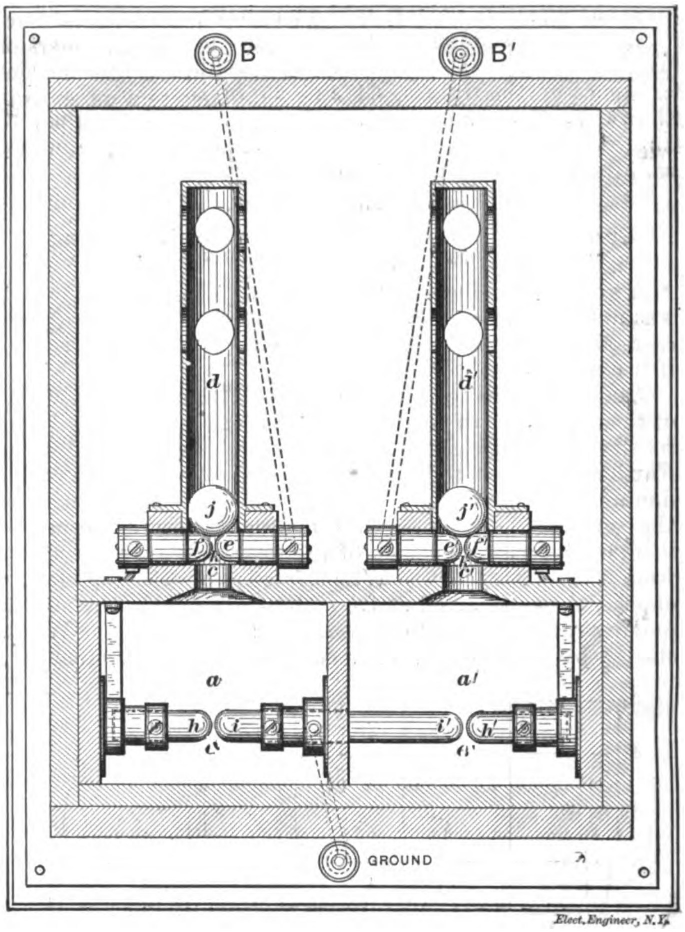


Fig. 2.

The action which takes place on the reception of a lightning stroke is very simple, and is as follows:—

The arc formed at either, or both, of the jumping spaces, *l l'*, instantly heats and expands the air in the respective air chamber, which, rushing up through the passage *c* or *c'*, blows the carbon ball to the top of the tube. The arc formed where the circuit has been broken by the projected carbon ball is at the same time instantly blown out, thus completely rupturing the circuit. The only demonstration is a slight puff as the air rushes out of the holes near the tops of the tubes.

As the carbon balls are confined by the tube, they at once drop back to their former positions and thus automatically place the apparatus in condition to receive another lightning charge.

We recently had occasion to witness the operation of this ingenious arrester, during which, in the absence of an actual stroke of lightning, the jumping spaces *l l'*, were bridged over with a fine wire in order to start the arc. The terminals of the arrester were connected to the circuit of a 3,000 light alternate current machine at 1,000 volts pressure. By the throw of a switch the full pressure of this machine was put on the arrester, and the action of the fusing of the temporary bridge wire, the starting of the arc, the blowing up of the balls and extinction of the arc were so rapid, indeed so instantaneous, that the lights on the circuit showed no flicker whatever.

We may add that the action is so rapid that the carbon pencils and balls show no deterioration after numerous trials.

THE WALKER ELECTRIC METER.

Ever since electric lighting became a commercial success, there has existed a desire on the part of consumers of current to be able to check the amount of the charges made by lighting companies, by reference to a meter, and a variety of forms have been devised with this object in view, and involving many novel and ingenious principles. In seeking to solve this problem in a practical manner, Mr. G. W. Walker has for some time been engaged on the development of an apparatus which embodies several novel features, and the operation of which places at the disposal of the consumer a complete record of the operation of his circuit, and the current consumed. The apparatus may be said to be one in which the current strength is continuously photographed, and the manner in which this is accomplished will be readily understood by reference to the accompanying engravings. The illustration, Fig. 1, shows the meter, which will be seen to consist in the first place of an ammeter coil consisting of a solenoid in which an iron wire in the shape of a nearly complete circle is placed as a core. To the same shaft to which the circle or core of the ammeter is attached there is also fixed a light aluminum sector, provided with a fine vertical slot, and immediately behind this sector is a box which encloses a roll of sensitized photographic paper, and which is shown enlarged in Fig. 2. The screen placed between the sector and the box has a horizontal slot, before which the sensitized roll is made to pass, as will be explained presently. The vertical slit in the sector is so arranged as to come immediately in front of the horizontal slit in the screen, so that in whatever position it may be, it will allow a ray of light to pass from the lamp, shown in Fig. 1, on to the sensitized roll.

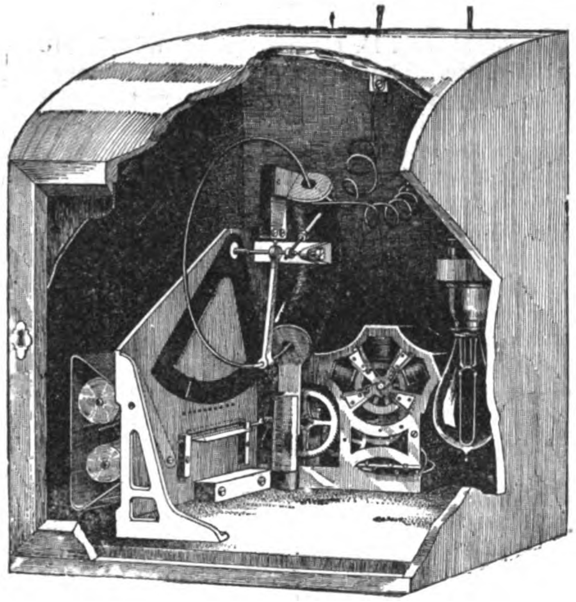


Fig. 1.

In this way it will be evident that, depending upon the strength of the current passing through the solenoid, the sector will take up a corresponding position, which will be indicated by the impression made by the ray of light upon the paper, which will be farther away from the end of the box as the current is increased. It will also be noted that immediately below the slot in the screen is a series of perforations which permit the light from the lamp to pass through continuously, and thus indicate on the paper a continuous series of lines, which, in Fig. 3, are represented by the horizontals shown. The perforations are so placed that each of these horizontal lines represent a certain strength of current in amperes. The movement of the brass sector attached to the ammeter and provided with a slot passing over the horizontal slot in the screen causes the spot of light to record the ampere strength at each interval of time, in the manner shown in Fig. 3.

It is evident, howvever, that some means must be provided for causing a continuous movement of the paper roll, and this is effected by means of a small clock movement which is wound every hour by the small electric motor which is shown in Fig. 1. The clock movement remains stationary when no current is on the circuit, but starts immediately upon the lighting of even one lamp. This clock movement, at intervals of one hour, also turns a shutter and allows the light of the lamp to pass through a slot in the screen, so as to impress upon the gelatine film the vertical lines shown in Fig. 3, and which indicate hours of service. In this way there is impressed upon the paper roll a complete record of the current consumed in the circuit.

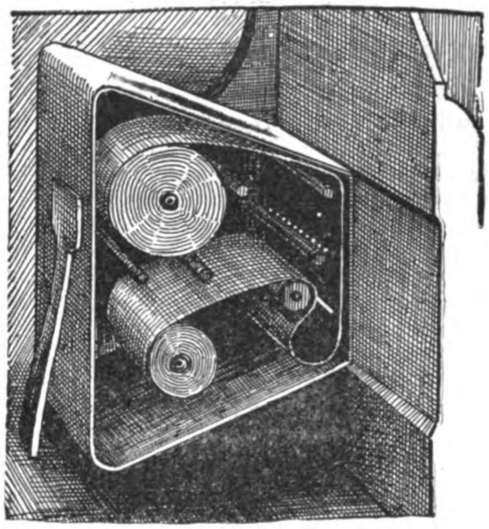


Fig. 2.

This roll, after a certain time, say one month, is taken from the box and developed so as to fix the light impressions, and can then be measured up in the same way as an indicator card, and the current consumed calculated at once. The consumer is, therefore, at any time, able to check the charges made. The entire apparatus is enclosed in a very small space, and the current consumed by it in its operation is only a fraction of that required by a single lamp, $\frac{3}{16}$ of an ampere being sufficient to set the apparatus in operation.

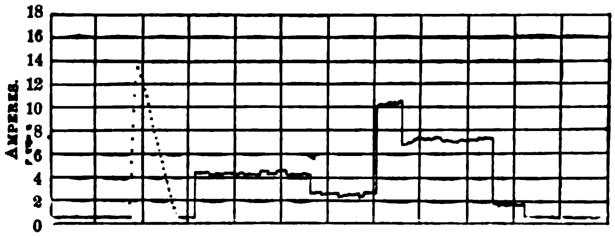


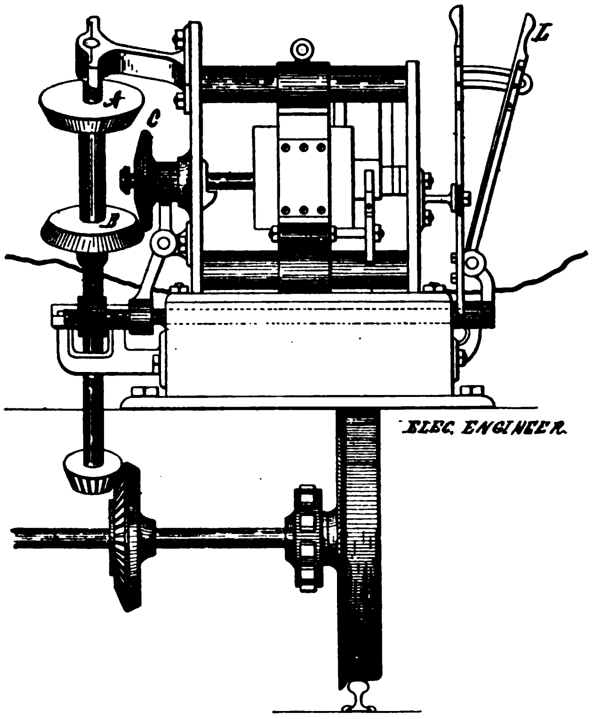
Fig. 3.

The instrument, while having no delicate parts, is quite accurate, and in a recent test of the same made by Mr. Geo. B. Prescott, Jr., the indications of the meter were compared with a carefully standardized Weston ammeter reading to hundredths of an ampere, and it agreed remarkably well both on rising and falling currents. The tests extended through the full range of the instrument, and the load was varied by single lamps taking from $\frac{35}{100}$ to $\frac{42}{100}$ ampere each, these small differences being distinctly recorded. This accuracy of indication is, no doubt, due to the fact that the recording is done in the manner shown, thus eliminating all friction due to marking points, and the core being relieved of all mechanical work.

We may add that the meter, which is manufactured by the Walker Electric Co., of this city, will be still more simplified by the substitution of a vibrator for the motor which winds the clock movement.

HENRY'S DRIVING GEAR FOR ELECTRIC CARS.

One of the first in this country to take up the subject of electric railways from a practical standpoint was Mr. John C. Henry, who in the early part of this decade operated a short experimental line at Kansas city. From the very first Mr. Henry has been a staunch advocate of the practice of supplying the car with but a single motor and, what is still more important, arranging it so that the motor shall be kept in continuous operation at the same speed, no matter at what speed the car might be running. By this method of operating, Mr. Henry reasoned, the motor would always be working at the maximum efficiency for which it was designed; while at the same time it obviated the difficulties met with in the case where the motors are continually started and stopped with the cars. One of the ways in which this is carried out by Mr. Henry is shown in the accompanying illustration, and will be seen to consist in the application of friction gear. The driving disc C is continuously revolved by the armature shaft of the motor and by means of the lever L can be thrown into, or out of, contact with the discs A and B. The latter are also controlled by a lever and drive the car in either direction according to which one is placed in contact with the driving wheel.

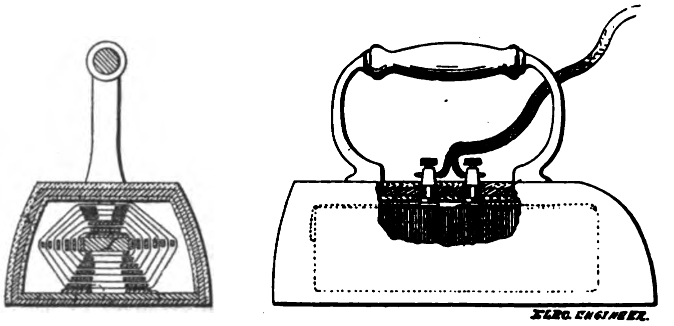


Henry's Driving Gear for Electric Cars.

In a recent patent, in which he describes this arrangement, Mr. Henry also shows an early method employed by him for maintaining contact between the trolley and the overhead conductor, consisting of wheels having grooved faces and held by spring pressure against the sides and bottom of the conductor.

AN ELECTRIC FLAT IRON.

The heating properties of the electric current have already been applied to a variety of purposes in the arts, the most prominent of which is the electric welding method developed by Professor Elihu Thomson. But it seems that in household purposes also, this property of the current is destined to play a prominent part. Electric cooking utensils of various kinds have been designed, and in some instances put into practibal operation. One of the latest novelties in this respect is an electric flat iron which has recently been patented by Messrs. H. R. Butterfield and W. Mitchell, of Waterville, Me. The apparatus, which is illustrated in the accompanying engravings, is so simple as to hardly require more than the briefest explanation. It consists of a hollow flat iron, in the interior of which a coil is placed which is heated by the current passing through it. The ease and comfort derived from the use of such a device, in hot weather especially, is apparent.



An Electric Flat Iron.

DEATH BY ELECTRICITY.

BY OTIS K. STUART.

The recent discussions, which have been prompted by the passage of the new execution law in New York state, upon the qualifications, so to speak, of electricity as a killing agent, have suggested certain opinions as to the manner in which death is produced by this agent; and these opinions have been aired in the columns of many journals both electrical and otherwise. The variety of the opinions, and of the manner of forming and stating them, shows a sad lack of true scientific method in the investigations of those who hold them; for there is apparent an almost entire and universal misapprehension of the nature of the problem involved.

The object of this paper is to present to electrical men a view of the problem, and to point out the manner in which it must be *attacked* if solution is desired.

Life in the animal organism is the result of a continual effort, by certain elements of known chemical affinity, to seek equilibrium by combining, counter-balanced by the continual tendency of environment to overcome or destroy this equilibrium. A muscle in performing its function gives off energy; this energy is derived indirectly from the outside world; but directly it is the result of a disturbed balance in the equilibrium of the elements composing the muscle. The same may be said of any of the organs of the body—the brain, the stomach, the entire nervous system. That this is so, will be clearer if we examine more closely the actions of one of these organs, say, the nervous system, from the beginning to the end of a performance of a function.

In the first place, it will be noticed that in order that function may be *started*, some stimulus must be made to act upon the organ,—the possible exciting forces, in the case of the nervous system, being numerous. For example, we may mention motion or mechanical irritation, change of temperature, electricity, light, odors, sound, etc. These forces *must* act as stimuli upon the nervous organism by some property which they have in common; and, as Mr. James Hinton says,[1] it is hardly possible to conceive this common property to be other than the power which they all and each have of "disturbing an unstable chemical equilibrium." This action of the stimuli, therefore, results in a chemical change in the make-up of the organism, as is proven by the fact "that the same stimulus will not reproduce the effect until after the lapse of a certain interval." The organism must be supplied with those elements which will restore it to its former condition of equilibrium, and *time* is necessary. This chemical change which generally is at the start local—at the surface of the body—is propagated along the nerve as a current, or produces a current of motion, so to speak, in the nerve, which constitutes its *function.*

In health, therefore, the normal equilibrium is easily destroyed; but it is as easily restored. Stimuli act powerfully and at once in the healthy organism, and so do the forces which tend to restore balance—the forces of nutrition which are also *chemical.* Contrari-wise, sickness is that state of an organism in which equilibrium is not restored soon after it is destroyed by the operation of function or of the stimuli which produce function. Sickness must be the result either of *over-sensitiveness* of the organism or of relative weakness of nutrition, or of both; and death results when either one or both of these causes become so powerful as to permanently destroy consciousness and vital power.

If this dictum is correct, any one of the above-named forces, if exerted with sufficient intensity upon the organism, must be capable of producing death; and I think every person will be able to enumerate at least a serious illness resulting from each of the causes mentioned. Vomiting is sometimes caused by the bad odor of a substance, and in certain cases is so violent as to cause serious illness, even death itself; high temperatures, or low ones, produce affections, both local and in the entire system; electricity produces paralysis, unconsciousness and death; tremendous explosions—sound—frequently destroy the sense of hearing, and sometimes occasion permanent mental disturbances; and it is well known that sudden or intense light will cause blindness, while little light or comparative darkness will increase in a painful degree the sensitiveness of the retina.

The conclusion we reach in regard to electricity is, therefore, that it is simply one of the many agents or forces which affect the animal organism, even unto death, by the known power it has of promoting chemical change, or, which is the same, the power it has of destroying one chemical equilibrium to establish another.

This does not solve the problem, for electricity affects other portions of the animal organism as well as the nervous system. It will affect muscular action directly, that is, without the medium or use of the nerves; and, in fact, does so with great power, as will be seen by the fact that it considerably hastens the decomposition of animal matter after death. It will make the "hair stand on end!" But, aside from this, the problem will not be completely solved until, as is evident, those chemical changes produced in the organism by the force of the current are understood. Indeed, not even then will solution be complete; for we will still be ignorant of the manner, the method by, or in, which these changes affect the *vital* functions. But that this is the line of investigation which will lead to the ultimate solution of the problem is, I think, beyond dispute. It is a problem in physiological chemistry, pure and simple.

.... **There** is much pleasure and some profit to be got from tinkering among models when we are boys, but when a young man has chosen a trade or art, he can only learn that trade or art by working under the actual conditions of that trade or art.—*Fleeming Jenkin.*

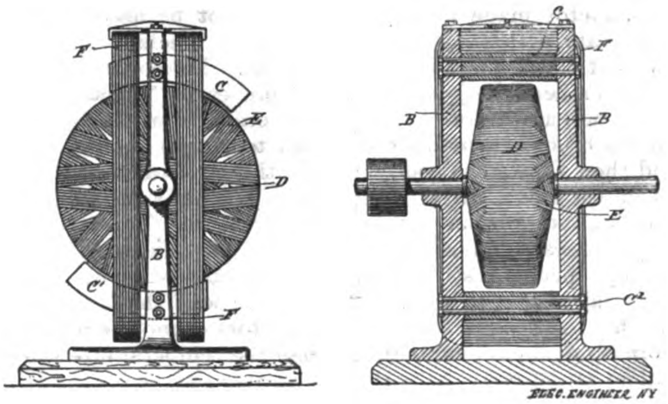
A NEW TESLA ALTERNATING MOTOR.

Our readers are already acquainted with the Tesla alternating current motor, which has now gone into practical application, and the operation of one type of which is based upon the fact that when an alternating current is passed through the coils of such a motor, the field magnets or poles do not appear to manifest their attractive effect upon the armature simultaneously, the magnetic attraction of some appearing to lag behind that of others, with the result of producing a torque and rotation of the motor.

Mr. Tesla has, however, developed another form of these so-called "magnetic lag" motors, but in operation it differs from those just described, in that the attractive effects or phases of the poles, while lagging behind the phases of current which produce them, are manifested simultaneously and not successively.

The manner in which this is carried out, is shown in the accompanying illustrations, Figs. 1 and 2, which represent respectively an elevation and side view of the motor.

As will be seen, the motor has two laminated magnetic pole-pieces C C′ of soft-iron or steel. The laminated disc-armature D is mounted between the pole-pieces C C′, which are curved to conform to the circular shape of the armature. The latter is provided with a closed coil winding. The main energizing coils F F are arranged so as to include within their magnetizing influence both the pole-pieces C C′ and the armature D, the pole-pieces C C′ projecting out beyond the coils F F on opposite sides, as shown.



Figs. 1 and 2.
New Tesla Alternating Motor.

If an alternating current be passed through the coils F F, rotation of the armature will be produced, and this rotation is explained as follows:—

An impulse of current in the coils F F, establishes two polarities in the motor. The protruding end of pole-piece C, for instance, will be of one sign, and the corresponding end of pole-piece C′ will be of the opposite sign. The armature also exhibits two poles at right angles to the coils F F, like poles to those in the pole-pieces being on the same side of the coils. While the current is flowing there is no appreciable tendency to rotation developed; but after each current impulse ceases or begins to fall, the magnetism in the armature and in the ends of the pole-pieces C C′ lags or continues to manifest itself, which produces a rotation of the armature by the repellent force between the more closely approximating points of maximum magnetic effect. This effect is continued by the reversal of current, the polarities of field and armature being simply reversed.

One or both of the elements—the armature or field—may be wound with closed induced coils to intensify this effect. Although in the motor shown there is but one of the fields, each element of the motor really constitutes a field, wound with the closed coils, the currents being induced mainly in those convolutions or coils which are parallel to the coils F F.

Mr. Tesla has designed various types of motors on this principle, among them one having a number of fields, which is particularly adapted to a rate of alternations corresponding to those now in general use on alternating circuits.

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[1] See "*Life in Nature*;" chapter i. By James Hinton.

DETERMINING THE SIZE OF WIRES FOR RHEOSTATS AND REGULATORS.

There are few electric circuits, whether intended for light or power, which do not require regulation of some kind, and the calculation of rheostats or regulators to effect this frequently enters into the determinations of the electrical engineer. Very few reliable data, extending over a wide range, have been forthcoming on this important subject up to the present, and our readers will, therefore, be interested in the tables recently given by Mr. A. B. Herrick, in *The Electrical World*, which, as we happen to know, are the result of a large and varied practice in the construction of regulators of all kinds.

There are a number of ways in which resistance wires may be mounted; but the method most universally used is to wind the bare conductor in such lengths as required on a mandril; the spiral is then slipped off and slightly stretched to separate the different convolutions. Evidently a conductor made up in this way cannot be used at any temperature that will sensibly affect its mechanical properties of elasticity and tensile strength. Moreover, at such high temperatures oxidation is more easily effected and the conductors more rapidly deteriorate from this cause. Metals brought a number of times to a high temperature and then allowed to cool, which is the practical condition when used as a variable resistance, gradually disintegrate and lose their fibrous or crystalline structure. This is especially noticeable in high resistance alloys. In addition to this the specific resistance of the conductor is increased by being raised to such high temperatures. (See Table I.) These are the practical reasons why conductors cannot be used at more economical temperatures than the temperatuure they will be raised to by the current in amperes given for the different metals and diameters in Tables No. II., No. III. and No. IV. These tables have been figured from actual experiments made under practical conditions. In column No. 1 of each table is given the capacity in amperes of galvanized iron wire, tinned iron wire and German silver wire wound in spirals and mounted in wooden boxes, where fair ventilation is given. The current capacity of these wires is the maximum that should be allowed where wood or combustible material is used in construction.

TABLE I.

Iron wire. Temperature.	Resistance.	Copper wire. Temperature.	Resistance.	Platinum wire. Temperature.	Resistance.
0° C.	640	0° C.	814	0° C.	1,870
21° C.	691	21° C.	864	21° C.	1,986
285° C.	1,660	Scarcely incandescent.	2,100	Barely incandescent	4,300
Commencing to color	2,250	Carmine red	2,450	Red hot	4,700
Dark grey	2,460	Brick red	3,300	Light red	5,050
Scarcely incandescent.	3,050	Bright red	4,700	Orange	5,400
Dark red	3,200	21° C.	910	Light yellow.	6,000
Bright red	3,650			21° C.	1,984
Red hot	4,550				
White hot	4,880				
21° C.	727				

A spiral loses its heat by convection much more rapidly in a horizontal than in a vertical position, and it will always be advantageous to design the resistance box so that when in use the spirals will be in a horizontal position. The box or frame in which these spirals are mounted should be open on the sides to admit free access of air.

In using columns No. 1 in the Tables Nos. II., III., IV., the wires can be used at the amperes capacity given, independent of the size of the box, and the total number of watts lost in the regulator.

Columns No. 2 give the amperes that can be carried by these wires where fire-proof construction is used. Columns No. 3 give the capacities that can be used for the special purpose of starting shunt wound motors. The amperes given are the currents which the wires will stand for one minute, and as forty seconds is ample time to start a motor under full load, the factor of safety is such that the wires would be brought only to a very dull red if by accident the starting

TABLE II.

Galvanized Iron Wire, Grade "B."

Washburn & Moen wire gauge.	D. Diameter in mils.	D². Circular mils.	1. Maximum safe current in amperes in wood frames.	2. Maximum safe current in amperes in iron frames.	3. Maximum safe current for one minute.	Ohms per foot.	Feet per ohm.	Pounds per foot.
3.	244	59,536	55	63.8	125	.00155	645	
4.	225	50,625	48	55.6	110	.00182	549	
5.	207	42,849	41	47.5	90	.00216	463	.1135
6.	192	36,864	30	34.8	78	.00251	398	.0973
7.	177	31,329	26	30.1	67	.00296	337	.0831
8.	162	26,244	23	26.6	56	.00353	283	.0695
9.	148	21,904	20	23.2	46	.00423	236	.0580
10.	135	18,225	17	19.7	36	.00508	196	.0483
11.	120	14,400	14.5	16.2	32	.00643	155	.0388
12.	105	11,025	12	13.9	22	.00840	119	.0292
13.	92	8,464	10	11.6	17	.01094	91.4	.0224
14.	80	6,400	8	9.28	13	.01447	69.1	.0169
15.	72	5,184	6	6.96	11	.01786	56.0	.0138
16.	63	3,969	5	5.8	8.9	.02333	42.8	.0110
17.	54	2,916	3.7	4.29	8	.03176	31.4	.00868

TABLE III

Tinned Iron Wire Tables.

B. & S. Gauge No.	Mils D.	Circ. mils D².	1. Maximum safe current capacity. Wood frame.	2. Maximum safe current capacity. Iron frame.	3. Maximum safe current capacity for one minute.	Ohms per foot. Legal.	Feet per ohm.	Resistance in legal ohms per 100 feet.	Pounds per foot.
8.	128.4	16509	17.4	20.8	43.6	.00398	250.	.398	.040
9.	114.4	13094	14.6	17.1	36.6	.00578	173.	.578	.033
10.	101.8	10381	12.3	14.3	30.8	.00728	137.	.748	.02751
11.	90.74	8234	10.3	12.	25.8	.009177	108.	.878	.02182
12.	80.80	6529	8.7	10.1	21.7	.011571	86.4	1.198	.0173
13.	71.96	5178	7.3	8.5	18.3	.014588	68.5	1.473	.01372
14.	64.08	4106	6.1	7.1	15.3	.018396	54.3	1.983	.01089
15.	57.06	3256	5.1	6.	12.9	.023198	43.1	2.373	.00863
16.	50.82	2582	4.3	5.	10.8	.029258	34.1	3.003	.00685
17.	45.25	2048	3.6	4.2	9.1	.036883	27.1	3.843	.00543
18.	40.30	1624	3.0	3.5	7.6	.046515	21.4	4.924	.00430
19.	35.89	1252	2.52	2.9	6.3	.060319	16.5	6.124	.00341
20.	31.96	1021	2.17	2.5	5.4	.073962	13.5	7.594	.00271
21.	28.46	810	1.82	2.1	4.5	.09332	10.7	9.974	.00231
22.	25.34	642	1.53	1.77	3.8	.11769	8.49	12.594	.001838
23.	22.57	509	1.28	1.49	3.2	.148426	6.73	16.056	.001457
24.	20.10	404	1.08	1.2	2.8	.187165	5.34	19.536	.001155

coils were left in circuit. These capacities are only to be used with fire-proof construction.

In column No. 1, when the wire is mounted in a wooden box, with fair ventilation the heat limit is found to be 39 degrees Cent. In column No. 2, with fire-proof construction and with slate or porcelain used as an insulator, and with free access of air, the heat limit is 48 degrees Cent., the temperature of the surrounding air being 22 degrees Cent. In column No. 3 the temperature attained varies as the time during which the current is passing through the wire, the maximum being about 400 degrees Cent.

In the case of galvanized iron wire table, the Washburn & Moen gauge is used, as by this gauge this wire is most readily obtained in the market. The wires on which these resistances were figured is on what is known as grade "B," one mil-foot being equal to 92.6214 legal ohms at 15.50 degrees Cent. This wire has a resistance about 8 per cent. higher than the best grade of galvanized iron wire used in line construction. The resistance per cubic centimetre will vary from 1 to 1¼ per cent., depending upon the per cent. of carbon in the iron and the thoroughness with which the galvanizing has been done. At a temperature of about 18 degrees Cent. the resistance increases about .41 of one per cent. for each degree. If any greater degree of accuracy than 1¼ per cent. is required, a sample of the wire to be used in the construction of the resistance should be tested for its conductivity. Resistance in the tinned iron wire table was determined from ordinary tinned iron wire. The resistance of different samples may vary about 1½ per cent. from that given in the tables.

TABLE IV.

German Silver Wire.

B. & S. Gauge No.	D. Diameter in mils.	D². Circular mils.	1. Maximum safe current in amperes.	Ohms per foot.	Feet per ohm.	Pounds per foot.
10 ...	101.9	10381	8.5	.016640	60.9	.029858
11....	90.7	8234	5.4	.020976	47.6	.023783
12....	80.8	6529.9	4.6	.026448	37.8	.018860
13....	72.0	5178.4	3.8	.033344	29.9	.014957
14....	64.1	4106.8	3.2	.042048	23.7	.011859
15....	57.1	3256.7	2.7	.053024	18.8	.009406
16....	50.8	2582.9	2.3	.066864	14.9	.006456
17. ..	45.3	2048.2	1.9	.084304	11.8	.005914
18. ..	40.3	1624.3	1.65	.106320	9.40	.004693
19....	35.8	1252.4	1.21	.137872	7.25	.003591
20....	32.0	1021.5	.99	.169056	5.91	.002935
21....	28.5	810.1	.88	.213168	4.69	.002327
22....	25.3	642.7	.66	.268784	3.72	.001843
23. ..	22.6	509.45	.55	.338960	2.95	.001463
24....	20.1	404.01	.488	.427408	2.33	.001159
25....	17.9	320.04	.434	.538944	1.85	.000921
26....	15.9	254.01	.385	.679632	1.47	.000731
27....	14.2	201.5	.343	.857008	1.16	.000669

It will be noticed in comparing the different tables that different wires carrying the same amperes have all about the same resistance per foot; there is a slight difference in favor of galvanized iron wire, which may be accounted for by the zinc covering radiating more readily than the bright surfaces of tinned iron and German silver wires.

The formulæ which agree most closely with the curve plotted between ampere carrying capacity and diameter in mils to bring the wires to the temperatures given were in column 1, $c = .012\,d^{3/2}$; in column 2, $c = .014\,d^{3/2}$, and in column 3, $c = .031\,d^{3/2}$, and also in column 3 the heating effect on the wire will be found to correspond very closely with the specific heat of iron as given by Tyndall, that 2,000 foot pounds are required to raise one pound of iron from 0 to 100 degrees Cent. The high specific heat of iron is of great advantage in the case of starting shunt wound motors, as a large amount of energy disappears in raising this wire to a high temperature.

RESULT OF THR PARIS ELECTRIC METER COMPETITION.

In the month of March of last year, as our readers are aware, the city of Paris organized a competition and offered various prizes for electric meters, with the object of adopting the best for use on the circuits supplied by the electric lighting stations operated by the city. This competition was entered into by a number of inventors, and the report of the committee who made the tests upon the various meters submitted, has just been rendered. The number of competitors entered was 28, and included all the best known meters now in existence.

The results attained by the committee were such that they were constrained to report that none of the meters was of sufficient merit to warrant the award of the prize of 10,000 francs for the best, nor that of any of the other prizes designated in the original articles of the contest. But among those submitted a number had exhibited such merit as to entitle them to recognition, and, in accordance therewith, the committee recommended the granting of the following sums: 2,000 francs to M. Cauderay, 2,000 francs to M. Aron, and three sums of 1,000 francs each to MM. Brillié, Blondlot and Jacquemier.

As the competition did not accomplish the object for which it was instituted, due partly to the shortness of the time given to inventors to prepare for the same, a new competition has been organized, of which the following are the conditions:

ELECTRIC METER COMPETITION FOR 1890.

1. The competition will be open to all inventors of electric meters or registers applicable either to continuous currents only, to alternating currents only, or, simultaneously, to both forms of current.

2. The apparatus submitted may be ampere-hour meters or watt-hour meters.

3. The meter ought to be direct reading and have an integrating device of such a nature as to show at once the total current consumed.

4. Meters ought to be able to register at very small currents; the quantity meters ought to start with $\frac{2}{10}$ of an ampere, and the energy meters at 20 watts.

5. The meters, accompanied by an explanatory note, must be deposited in a sealed package at the Hotel de Ville at the office of the "Sous-Directeur des Travaux," Paris, before the 31st of August, 1890, at the latest.

6. The meters presented will be submitted to the judging of a Committee of nine members, five of whom will be designated by the Municipal Council, and four by the Administration.

7. The apparatus will be submitted to the following comparative tests: Their exactness over the whole scale for which they are designed; their practical value as regards regularity of operation, simplicity, cost, etc.; the energy consumed by them during operation; the attention required by their employment in the distribution of current.

8. The sum of 18,000 will be distributed under the following conditions: 10,000 francs to the inventor producing a meter giving every satisfaction and applicable equally well to alternating and continuous currents. In case the meter can only be applied to one of these two currents, the inventor will be entitled to one-half of this prize. Prizes amounting to 2,000 francs to meters destined at the same time for alternating and continuous currents, and 1,000 francs for meters applicable only to one of these two currents will be distributed to inventors whose apparatus indicates important progress.

.. THOSE who take part in the endowment of research are the truest and greatest of modern philanthropists.—*Professor Robert H. Thurston.*

. .. THE mechanic well knows that absolute truth is unattainable, but he nevertheless values highly the approximation to truth which allows him approximately to ascertain the result of given simple material combinations.—*Fleeming Jenkin.*

.... To Faraday the space round conductors was full of what he called lines of force; and it is his main achievement in electrostatics to have diverted our attention from the obvious and apparent to the intrinsic and essential phenomena.—*Oliver J. Lodge.*

.... THE subject of thermo-electricity has been eclipsed by the magnificent development of the dynamo-electric machine, but we may yet return to thermo-electricity as a practical source of electricity.—*Professor John Trowbridge.*

.... LET us *make* a place for physical science in our lowest schools and give to every pupil, every boy and girl in the land some knowledge of physical forces. Above all, let the lesson of conservation of energy be drawn from the various familiar cases of its transformation.—*Professor W. A. Anthony.*

PHENOMENA OF ALTERNATING CURRENT INDUCTION.[1]

BY PROFESSOR ELIHU THOMSON.

About three years ago I had the pleasure of bringing to the attention of the American Institute of Electrical Engineers at its annual meeting, certain phenomena of the repulsive action between conductors such as coils of wire traversed by alternating electric currents. It was then noted that if such a current be sent through a circuit wound as a coil, and either provided with an iron core, or not so provided, and permitted to induce in another coil or circuit, a current under conditions which allowed a lag or displacement of phase of the latter from its theoretical position, a repulsive effort would be exerted, tending to remove one coil from proximity with the other, or to deflect one of them to a position such that the plane of the coils would be at right angles,—one to the other.

Many modifications of the arrangements of the coils were described and apparatus based upon the principle of inductive repulsion, as I called it, were touched upon. I need not now enlarge upon these matters. It may suffice to say that current indicators and potential indicators or voltmeters have been constructed embodying the principle as applied to the quantitative measurement of alternating currents. Arc lamps have been made in which the regulation of the carbons has been effected by the repulsive action of a coil traversed by the current fed to the lamp, or by a derived current around the arc, acting on a closed band or circuit movable with the regulating and feeding frame of the lamp. Various forms of alternating current motors have been made in which the revolving portion is composed of coils arranged to be closed upon themselves, and inductively acted upon by the currents in what may be called the field or inducing coils connected with the alternating current source. The principle has been applied in other apparatus, such as regulating mechanism for alternating currents and in electric meters.

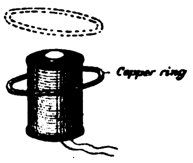

FIG. 1.

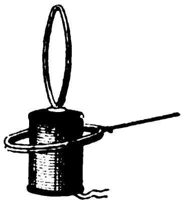

FIG. 2.

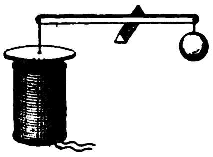

FIG. 3.

It is my purpose this evening to bring before the Institute some experimental apparatus showing the action of inductive repulsion in some of its phases; following this by a brief account of a number of other effects somewhat allied to it, with experimental demonstrations of the same. Some of these experiments were to be seen at the Paris Exposition of last year in connection with my exhibit there, and others of them are more recent still, while still others have never been shown at all in public. The field is a fruitful one, and there is not time to touch upon other than the more striking, and perhaps interesting, phases of the actions exhibited, which are susceptible of modification to a great extent by changes in proportion and arrangement of apparatus.

I may here revert to one experiment which is almost a repetition of one I made about five years ago. If a copper disc or closed coil be balanced in front of another coil and parallel thereto, it will be noticed that on passing a current into the second coil, the disc or closed coil will be repelled slightly, and if the current be afterwards shunted or cut off, there will be a slight attraction. By opening and closing the shunt so as to put the current successively on and off the coil, there will be alternate repulsions and attractions exhibited. Let the current, however, be so put on and off very quickly and the attractive effect will become less than the repulsive effect, and the disc or closed coil will be driven away or bodily repelled. Replace now the intermittent current by an alternating current which reverses many times per second and the repulsive effect alone is noticed, provided that the disc or closed coil is of sufficient mass and conductivity to allow currents of high self-induction to be set up in it, whereby such disc or coil or current in it may, as it were, exert a controlling influence upon the magnetic field in immediate proximity to it.

The amount of this repulsive effect may, under favorable circumstances, become so great as to give with moderate current densities a very considerable pressure or force.

I have selected some particular instances of this action for our experiments, as it will be understood that time is too short to show many variations of the effect as found in numerous experimental trials.

Placing a copper ring over a coil which has been wound upon an iron core, and passing an alternating current through the coil, gives so much repulsive effect that the ring is thrown forcibly away and up into the air (Fig. 1). Or, again, the ring may be supported for a moment in free air, though its condition is one of unstable equilibrium. Further, we may arrange a string or thread to so guide the ring that it cannot move laterally though free to fall towards the alternating current coil (Fig. 2). It is in this case supported in the magnetic field of the coil and away from it. It takes a position of balance between the repulsive effect and its own weight, which are opposed forces. As a curious variation, another copper ring (Fig. 2) may be added under the former, to which it seems to be attracted as though magnetized, after which both rings are supported as one. The explanation is very simple. The currents induced in both rings are in the same direction at any instant and produce attraction. The bearing of this will be seen in later experiments where rotary actions are produced.

Copper plates are but imperfect discs and act as closed coils. Aluminum rings, having much less weight than copper, might at first be expected to be more readily supported, but it must be remembered that the conductivity of aluminum is much less than that of copper, and hence that since the effect depends on current induced and retardation of phase or lag of such current, copper is the better on account of its high conductivity.

By attaching the closed ring or coil to a balance beam (Fig. 3), we are able to measure the amount of force exerted with different currents, and different materials or constructions.

Such measurements show very decidedly that the repulsive effort depends on the strength of the current in the inducing coil, and in the ring or closed coil, and on the relation of the position of the waves of induced current in the closed coil or ring with those of the inducing current. The effects are, properly considered, magnetic repulsive effects of the opposing fields of the induced and inducing currents relatively.

When the closed coil or disc is mounted so that it can only turn on an axis in its plane then the repulsion resolves itself into a deflection of its plane to a position at right angles to the plane of the inducing coil, or, more strictly, to parallelism with the direction of the magnetic lines set up by such inducing coil. The effect of the control exhibited by such a closed circuit of good conducting power over the magnetic field of the inducing coil, is seen by interposing such closed circuits between the inducing coil and another coil acting as a secondary and feeding an incandescent lamp (Fig. 4). The light of the lamp is cut down and extinguished thereby, as the alternating field is now almost completely shielded from the secondary. The coil feeding the lamp undergoes a slight repulsion. This is easily exhibited by placing in a glass jar with water a lamp and coil, the lamp wires being connected with the coil terminals, and so loading it that it just sinks to the bottom of the jar. Placing this above the inducing coil so as to bring it into the alternating magnetic field, is attended not only with the lighting of the lamp under water, but there is noticed a repulsion or floating of the lamp to a certain point (Fig. 5), at which its tendency to sink just balances the repulsion exerted. So long as the lamp remains so suspended in the water its brilliancy is constant, notwithstanding that the strength of the inducing current be raised or lowered considerably. It is of course, unnecessary to use water to balance the lamp coil, a beam and counter-poise weight will suffice (Fig. 5a).

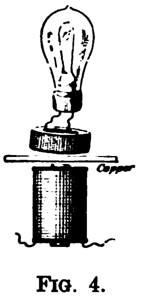

FIG. 4.

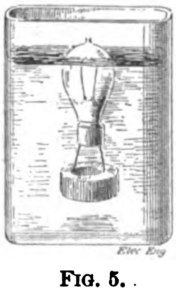

FIG. 5.

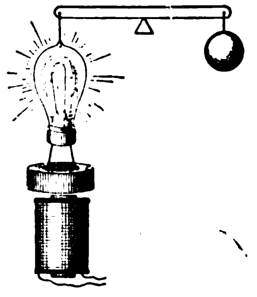

FIG. 5*a*.

In utilizing the repulsive action for obtaining movement from alternating currents, the closed coil or circuit may be mounted in various ways.

A convenient form is one in which a bent core of iron wire or plates which may be a ring is wound over with insulated wire at a portion only of its surface. A closed band or secondary is pivotally mounted so as to pass over the curved core and also over the wire covered portion if moved around the pivot by a suitable carrier (Fig. 6). A spring or weight may tend to cause the closed band to pass over the wire-covered portion of the core. Currents sent in the wire coil produce repulsion and movement of the closed band about the pivots to a position on the core removed from the coil.

This apparatus, and some of its modifications, is a valuable reactive coil which gives a smooth variation and hence is called a "smoothly acting reactive coil," for it enables us by changing the relation of the closed band or secondary circuit to affect the inductive resistance, as it may be termed, or the impedance of the coil wound on the core; the changes being made by swinging the closed band on its pivotal support by a suitable operating handle. It so varies the effects in an alternating circuit as to represent those of variable resistance in a continuous current circuit, but it does this without much loss of energy, and not by steps but through the finest gradations. The power is greatly increased by the provision of a movable iron armature for the core, centrally placed and pivoted, carrying the closed secondary coil upon it.

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[1] Abstract of a lecture delivered before the American Institute of Electrical Engineers, at Columbia College, April 2, 1890.

It is easy to see that by placing on a laminated armature core a series of coils which can be suitably short-circuited by a commutator and placing such armature between poles of alternating magnetic polarity, or, better, surrounding such armature by coils for producing directly in it an alternation of magnetic states, while the magnetic circuit is completed by an outside magnetic circuit of laminated iron, we have obtained a rotary motor for alternating currents which may be termed a transformer-motor, since the armature currents are induced and not obtained from the outside.

But by properly constructing such a machine it is not necessary to have a commutator if we are content to start the motor initially by some means, for we may close the armature coils on themselves, pass alternating current through the field coils so as to establish an alternating field in which the armature exists, and it will be found that the machine will turn in the direction in which it has been started and run up to a speed depending on the construction. I have constructed a number of such machines, some of which are self-starting without a commutator. They are made self-starting by special features of construction. Whether they can be made of high or fair efficiency remains to be seen. Using only one alternating current, they can, of course, be used on existing lines.

There are a number of curious effects to be described which depend on a shifting or propagation of magnetic lines of force. Many of these effects were worked out conjointly by Mr. M. J. Wightman and myself, and some of the ways of exhibiting them are due to the skill of my workmen carrying on the construction of apparatus.

The principles may be briefly stated as follows:

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another and tend to move into parallelism.

2. Iron or steel masses placed in an alternating magnetic field give rise to shifting magnetism, or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

8. Closed circuits in alternating magnetic fields, or fields of varying intensity, give rise to shifting magnetism or lines of force moving laterally to their direction and may, therefore, act to move other closed circuits in the path of such lines.

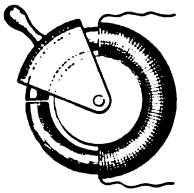

FIG. 6.

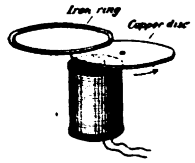

FIG. 7.

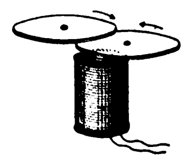

FIG. 8,

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

The experimental demonstration of these principles can be carried out with very simple apparatus. The explanations of the actions which occur in accordance with known principles are in many cases very evident and in others are arrived at with a little study. Nevertheless, the experiments illustrate in a marked manner properties of matter and peculiarities of magnetic action which will probably never be fully understood unless the nature of the ether and its relations to what we call matter are discovered.

We will return to the case of the ring attracting another ring to it. Here we have the case of like currents in parallel direction producing attraction. Such an action can be made continuous. We have only to place a ring or plate over the alternating current coil or pole of its core and then bring a copper disc free to revolve on pivots into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to shade it in part, as it were, while a part of the pivoted disc is placed under it, or over it, in front of the alternating field pole (Fig. 7). The disc then revolves from the unshaded portion of the pole towards the shaded portion where the closed ring or plate is placed.

The actions are due to lines of magnetic force at each alternation of current in the magnetizing coil below meeting a retarding influence or opposition to their development over that part of the pole shaded by the copper ring or plate, owing to currents induced therein. The copper disc is the seat of similar currents, but chiefly about those portions not shaded by the ring or plate. Owing to self-induction these currents in ring and plate tend to persist into the period of reversal of the field. This gives rise to a movement of those portions of the disc where current is flowing into a position directly adjacent to the ring or the currents flowing in it, an action which is repeated at every alternation and results in a revolution of the disc. While this explanation is probably the simplest it must be borne in mind that it is but an expression of a set of magnetic actions or changes in the magnetic field; such magnetic field being the resultant of the changing force of the original alternating inducing field and of the magnetic effects of the currents set up in the ring or plate and the disc, both of which latter have a retarding action due to self-induction of the currents in them.

If now two discs be used instead of one (Fig. 8), it will be found that they may each shade a portion of the pole and that the discs, if made to overlap, will both revolve in opposite directions relatively.

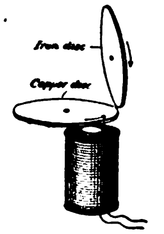

FIG. 9.

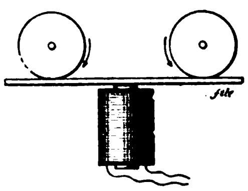

FIG. 10.

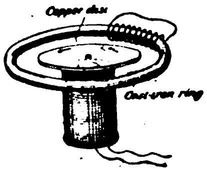

FIG. 11.

An iron disc may be substituted for one of the discs above and used with the fixed plate or ring below it and so be caused to revolve, and its position can be changed so that it is in a plane vertical to the plane of the plate or ring (Fig. 9). Also, it may be similarly used in relation to the revolving copper disc. In fact the positions of two copper discs pivoted so as to be revolvable, or of a copper and iron disc, may be greatly varied and effects of rotation obtained.

If we vary the experiment by placing a closed coil around a part of an iron core upon which is also wound a coil which can be put into an alternating current circuit the effects obtainable are similar to those described above; that is, the structure becomes capable of revolving copper or iron discs held near it. The direction of revolution is such as to indicate a propagation of magnetism or magnetic polarity at a retarded rate through that portion of the iron core covered by the closed coil. In this respect a bar of iron unlaminated or not divided is the same as a core surrounded by a closed coil, for it is also capable of causing the rotation of the discs, when such a bar is abutted to a laminated core alternatively magnetized, or when such a bar is surrounded at part of its length only by the magnetizing coil. A bar of steel substituted for the iron, even if well laminated, is able to cause brisk rotations of the copper or iron discs.

With hardened steel the action is the more marked, a file serving for the experiment. Here the "hysteresis," or coercive force, or magnetic friction, retards the propagation of the magnetic wave. By laying a large file flat-wise against the alternating magnet pole, at about the middle of the file, (Fig. 10), two discs of copper or iron may be kept revolving; or one each of copper and iron held over those portions of the file projecting from the pole of the magnet over which it is laid will revolve. The iron disc may be held vertically and the copper horizontally or flat-wise to the file.

Cast-iron behaves like steel, though more feebly. A ring of cast-iron having a closed coil wound on one part (Fig. 11), can be laid on the pole of the alternating magnet coil and it will rotate an iron disc concentric with it if the placing of the closed coil portion of the ring is not made so as to bring it either over the pole or diametrically opposite that point, the best effect being obtained when it is alongside of the pole.

A small motor of a curious type has been made, utilizing the principle of shading the pole by closed circuits. A laminated ring (Fig. 12), is wound over with wire, but has a slot cut through it dividing the ring and causing it to present two pole faces opposite to each other at the cut part. Each pole is arranged by a set of closed copper bands to be "shaded," as I term it. A copper disc free to turn introduced by one edge into the slot, turns rapidly and exerts some power.

Removing the disc it is found that a silver coin can be inserted into the slot and will be drawn into it and propelled with some force through the same, while a lead coin, or coin of base metal, will be scarcely affected. This is due to the vigorous currents which can exist in the silver, owing to its high conductivity, while the very low effect of the lead is due to the opposite cause.

To obtain a rotary effect on a copper disc we can, however, simplify matters very much by using no closed circuit at all, nor even a steel piece. We may place the disc partly over the alternating pole and then hold over the disc a bundle of iron wires or unwound core, taking care to offset its axes to some extent from that of the pole towards which it and the disc are presented. The result is at once a rapid revolution of the disc in the direction of the offsetting.

The rotary effects are utilized in the construction of electric motors and meters of more or less merit. They are capable of very great variation by changing the forms and relations of the devices used.

Some curious modifications of the effects are found in the revolution of copper balls or cylinders. A hollow copper ball may be laid on a plate of copper (Fig. 13), or within a ring of the same metal and set in gyratory movement, its direction of rotation as well as the position of its axis of rotation depending on the relation of the ball and the plate on which it rests or the ring which encloses it in relation to the alternating pole which is used to set it in movement.

It will even rotate on a horizontal axis while resting on a plate of copper; this requires that it rub its equator upon such surface and overcome the friction.

Placing the ball in a vase of water in which it floats and supporting the vase over the pole upon which has been laid a plate of copper partly covering the pole gives vigorous rotation of the ball in the water. Several balls of various sizes may be placed in the vase or a copper dish substituted for the plate, or the ball and dish both used together (Fig. 14). The effects of these latter are both amusing and instructive.

We need scarcely stop to consider that these actions are brought about just as the movements of the discs were set up by induced currents and shifting magnetic lines that are retarded by the closed circuit currents set up in the plates, rings. etc., which have been employed to modify the field.

But, as we have shown, it is not necessary for obtaining some of these effects that the field be modified by closed circuit currents. Slight changes in the position or shape of parts may be sufficient to give rise to rotatory effects. Thus we may place a cone or wedge of iron on the alternating pole (Fig. 15), and hold near it a copper ring mounted so as to be able to revolve. The ring in this case is best provided with a laminated iron interior which supports it and enables it to be easily mounted on a shaft. The copper cylinder revolves and its direction is such that it seems to be blown around by a blast from the edge of the wedge or point of the cone.

A curious electrical gyroscope is constructed as follows: A vertical pivot projects from the centre of the alternating pole (Fig. 16), upon which pivot is hung a horizontal rod, bearing on one side of the pivot a copper frame, in which is carried a copper ring or wheel with an iron inner portion, such ring or wheel being delicately pivoted in the frame in the usual way. The rod bears on its other end the counterpoise or balance weight. The copper frame bearing the ring is placed in an inclined direction with reference to the horizontal. Under these circumstances, rotation is given by the alternating field in which the instrument is placed, and the properties of the gyroscope are exhibited. It is needless to say that a little ingenuity may modify the instrument in form or lead to the construction on similar principles, of a variety of curious devices, receiving their movements from the actual space, as it were, in which they are placed and without direct connections of an electrical or mechanical character.

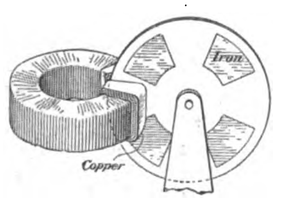

FIG. 12.

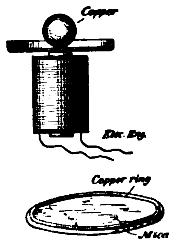

FIG. 13.

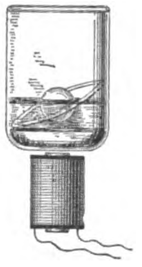

FIG. 14.

There is a growing tendency among electricians to regard the effects of what is called an electrical current in a conductor, to be due, in large part at least, to a movement of particles or to a transmitted strain which has its place entirely outside the wire or conductor, and in the space around such conductor. The wire and current in it, are regarded simply as the central core of a set of disturbances in the medium surrounding it, by which medium the energy of the current is actually transmitted, if the current itself is not merely an effect of such a set of disturbances in the surrounding medium.

Viewed in this light the phenomena we have been considering are seen to be simply the result of modifying these outside effects by conducting or magnetic masses placed in the medium subject to disturbance. The coil conveying the current sets up a changing set of strains in the ether around it, or rather the coil itself is only the centre of such strains transmitted into the medium surrounding the wire from the source of current used, which may be a dynamo located in a central supply station. The changing set of strains around the coil used in the experiments, can set up current in other conductors than the coil subject to their action. Thus are produced the induced currents in the copper rings, balls, plates, etc., used. Such currents react on the medium and modify the distribution of strains, and so give rise to the movements and other phenomena displayed.

The relation which exists between a primary inducing coil and a secondary coil in an inductive apparatus or transformer is of the same nature. The secondary coil is merely a conductor immersed in the medium which surrounds the primary coil. The latter and the wire leading to it from the source of current, is but the core of a set of disturbances or strains in the ether surrounding it, and in which the secondary coil is immersed. Hence the coils, though insulated from each other, are yet both immersed in the medium whose transmitted strains are the real expression of electrical energy transmitted. The result of this relation is, that, were it not for the fact that the coils must necessarily be made of imperfect conductors, the amount of energy transmitted to a secondary coil from its primary could be unlimited,—it might be thousands of horse-power, and the iron core of the transformer be only of such size as to be easily lifted in the hand.

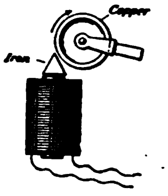

FIG. 15.

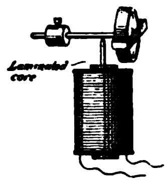

FIG. 16.

Let us imagine the primary and secondary coils of an induction apparatus made of pipe, through which a refrigerant is circulated, or around which a powerful refrigerating action is exerted, such as might be obtained by the evaporation of liquified gases, and in such case the resistance of the coils would become very small indeed. The coils could carry large currents without loss, and the amount of energy obtained in the secondary would almost keep pace with the energy supplied to the primary. A remarkable example of this wonderful capacity for energy transmission, is seen in some transformers for electric welding, in which 20,000 to 30,000 watts, or from 30 to 40 h. p. are transferred to the secondary coil from the primary, apparently, while the iron core or magnetizable core is of quite moderate dimensions. In fact, the iron core has but little to do with the capacity for transmission of energy by induction, though it affects the E. M. F. set up in the turns of wire of the coils.

Could we imagine an open coil without iron, composed of two interwound coils of copper wire or tubes insulated from each other, and kept at the lowest possible temperature so as to practically abolish the resistance of the copper, we would have an apparatus of the very highest efficiency for the transfer of electrical energy from one circuit to another, and one which could be of very moderate size, and yet transfer enormous amounts of such energy, to be used for lighting, metal working or other purpose.

There has only been time in this discussion to touch upon a few salient features of our subject about which a volume might be written at the present time, the object being to bring to the notice of the Institute rather the experimental demonstrations only, stripped of such theoretical considerations as would, if incorporated in this paper, have taken up much more than the space allotted to it and perhaps have exhausted the interest of the hearers.

THE COST OF ELECTRIC LIGHTS IN TOWNS AND CITIES.[1]

BY V. ROSEWATER, JOHNS HOPKINS UNIVERSITY.

QUESTIONS of an economic nature are becoming more and more topics for public discussion. The people, as a whole, are gradually awakening from that lethargy in which they were willing to allow anything and everything to take its own course, regardless of the public convenience. And now, in almost every city in the country problems of rapid transit, adequate water supply, or proper illumination of the streets are claiming the attention of the citizens. Probably no one of the larger cities has yet done entirely away with gas for out-door purposes; but all have, to some extent, made use of the modern substitute. From this the importance of the question whether such lighting should be undertaken directly by the municipal authorities or should be left to private enterprise ought to be clear to every one. Consequently, any investigation which will throw the light of general experience upon the matter should prove of great value and of general interest.

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[1] *The Independent*.

Some time last fall a committee of the Council of the city of Scranton, Pa., which had been appointed to investigate the matter of electric lighting and the differences which had arisen between the city and the local company, made its report. This committee, "in order to deal intelligently with the question in hand, had deemed it wise to correspond with other cities in the United States, and to gather such data as they might have to furnish for the guidance of their deliberations." The answers received as a result of this correspondence were tabulated for more convenient perusal, and now furnish not only the most complete but also the most reliable statistics upon the subject which have been compiled up to this time. The following table presents the figures for those cities in which arc lights were supplied by contract with private companies. All lamps are 2,000 candle power except in Newburgh, Norwalk, Richmond, Va., Northampton, Mass., Taunton and Concord, whose lights are 1,200 candle power. The area lighted is, in every case, the entire city. In Scranton alone the radius is a factor in the cost:

Name of Place.	No. Lights.	Cost per Annum.	Hours Lighted.
Alliance, O	8	$144 00	All night.
Janesville, Wis	8	100 00	Midnight.
Cedar Rapids, Ia	10	126 00	Except moonlight.
Gloucester, Mass	13	96 00	12 o'clock.
South Bend, Ind.	14	100 00	12 o'clock.
Union City, Ind.	22	95 00	Except moonlight.
Ashland, Penn.	23	125 00	All night.
Keokuk, Ia	24	126 00	Except moonlight.
Ogden	25	133 33	12 o'clock.
Bath, Me	27	100 00	5 all night, 22, 12 o'clock.
Keene, N. H	27	100 00	12 o'clock.
Chattanooga, Tenn	30	121 66	All night.
Wooster, O	30	108 00	All night.
Concord, N. H	39	100 00	12 o'clock.
Waltham, Mass	32	127 00	1 o'clock.
Jacksonville, Ill	32	100 00	Except moonlight.
Charleston, S. C	35	144 00	All night.
Fond du Lac	36	72 00	All night.
Lockport, N. Y	37	80 00	Except moonlight.
Asheville, N. C	37	100 00	2 A. M.
Burlington, Ia	39	130 00	2 A. M.
Taunton, Mass	44	110 40	Schedule moon.
Yonkers, N. Y	45	60 00	All night.
Wilkesbarre	48	144 54	All night.
Cortland, N. Y	50	50 00	12 o'clock.
Columbus, Ga	50	108 00	Except moonlight.
Vicksburg	50	114 00	Except moonlight.
Selma, Ala	50	120 00	Except moonlight,
Fall River	50	180 00	All night.
St. Paul	50	127 75	Midnight.
Defiance, O	52	60 00	
Lima, O	58	100 00	1 o'clock.
Pottsville, Pa	58	105 00	All night.
Portsmouth, N. H	60	100 00	All night.
Adrian, Mich	63	100 00	All night.
Winona, Minn	61	125 00	All night.
Hornellsville, N. Y	64	100 00	All night.
Springfield, O	64	130 00	All night.
Battle Creek, Mich	65	85 00	12 o'clock.
New Britain, Conn	66	100 00	12 o'clock.
Patterson	70	100 00	All night.
Eau Clare	70	110 00	All night.
Somerville, Mass	70	135 00	1 o'clock.
Burlington, Vt	70	116 00	12 o'clock.
Logansport, Ind	75	100 00	All night.
Mansfield, O	77	75 00	All night.
Saginaw	80	100 00	3 A. M.
Joliet	80	120 00	12 o'clock.
Norwalk	82	70 00	12 o'clock.
Wichita	83	83 33⅓	All night.
Northampton	88	75 00	12 o'clock.
Petersburg, Va	82	96 00	All night.
Newburgh	97	111 00	All night.
Binghamton	99	140 00	All night.
Indianapolis	100	80 00	All night.
Waterbury, Conn	100	142 85	All night.
Racine	100	70 00	All night.
Sedalia, Mo	100	87 00	Schedule moon.
Atlanta, Ga	100	120 00	All night.
Allentown	101	100 00	Except moonlight.
Watertown	102	68 00	1 o'clock.
Galesburg, Ill	104	105 00	All night.
Galesburg, Ill	104	69 00	12 o'clock.
Boston	105	180 00	All night.
Sandusky	115	100 00	All night.
Milwaukee	130	150 00	All night.
Chillicothe, Ohio	121	80 00	All night.
Richmond, Va	133	146 00	All night.
Lancaster	139	124 10	All night.
Zanesville, Ohio	140	70 00	Except moonlight.
Norwalk, Va	155	100 00	All night.
Reading	156	146 75	All night.
Akron	170	78 00	All dark nights.
Youngstown	180	72 50	All night.
Massillon	180	70 00	All night.
Jackson, Mich	180	88 89	All night.
Mobile	181	91 00	Schedule moon.
Dayton, O	200	150 00	All night.
Bloomington, Ill	211	108 00	All night.
Poughkeepsie	212	123 00	All night.
Lafayette, Ind	214	50 60	All night.
Terre Haute	232	70 00	3 A. M.
Harrisburg	270	90 00	All night.
Troy	271	158 00	All night.
Springfield, Mass	300	83 33	All night.
Scranton	323	90 00	All night.
Toledo	400	100 00	All night.
Minneapolis, Minn	480	150 00	Except moonlight.
Philadelphia	800	177 00	All night.
New Orleans	1,010	130 00	All night.
New York city	1,357	90 00	(Bid May 1.)

One need not have much knowledge of the subject to ascertain, by glancing at these figures, that the charges do not conform to the cost of production. The predominance of even figures would point to a merely arbitrary rate, while the partiality shown for a charge of one hundred dollars seems to indicate a desire on the part of the electric lighting companies to keep their books in the most simple manner. Where an odd figure is to be found, it may easily be inferred that the authorities and the company originally failed to come to an agreement. But the company, with great condescension, must have granted a reduction or offered to "split the difference," to which fact may be assigned the frequent form of 2½ or 3½.

A great imposition may be discerned in the relative charges for large and small numbers of lights. In the five cities consuming the largest number of lights, the average cost is far above that in the five cities consuming the smallest number. That something is radically wrong must be apparent. By one not initiated in the mysteries of city contracts, the very opposite would be expected. And if the charges were governed by the cost of production, that is what the statistics would show. Every increase in the number of lights is made at a less than proportionate increase in expenditure. The capacity of the plant may be doubled without doubling the investment. This is the primary characteristic of a natural monopoly, and every business in which this state of affairs exists must necessarily be viewed as monopolistic in its nature. Whether the fact that large cities using many lights are paying more per light than small cities using few, is the result of ignorance, imposition, or corruption, the fact still remains, and the only remedy is enlightenment.

Before proceeding further, it might be well to note one more peculiarity evinced by this investigation. The efficacy of competition as a regulating influence is something almost implicitly confided in by the American people. They do not recognize the monopolistic character of certain industries. Now in many instances it was stated in the answers received from the various cities that the city was illuminated by contract with two and often three different electric lighting companies. But in no single case was any variation in the charge noted. Each company received the same price per light as the others. The only explanation which can be made is that by some combination the same price was fixed for each company, and that the latter divided the territory according to mutual agreement. The impossibility of competition in this line of business could not have been more clearly illustrated.

We may now ask, what is the condition of affairs in those cities which own their own electric lighting plants? In the report of the Scranton committee, the statistics are given as follows:—

Name of Place.	No. Lights.	Cost per Annum.	Hours Lighted.
Martinsville, Ind	30	$40 00	Midnight.
Grand Lodge	32	62 00	12 o'clock.
Huntington	50	48 64	All night.
Decatur, Ill	52	60 00	All night.
Dunkirk, N. Y	55	36 50	All night.
Paris, Ill	60	36 00	Except moonlight.
Easton, Pa	64	100 00	All dark nights.
Aurora, Ill	75	56 00	Except moonlight.
Painesville, O.	80	35 00	Except moonlight.
Ypsilanti, Mich	80	23 61	12 P. M., not moonlight.
Madison, Ind	85	48 00	All night.
Lewiston, Me	96	42 00	All night.
Hannibal, Mo	96	52 00	All night.
Little Rock	110	47 50	When dark.
Bay City, Mich	134	60 00	All night.
Topeka, Kan	184	54 00	Eight hours.
Topeka, Kan	184	72 00	All night.
Chicago	293	65 60	All night.

The difference between this table and the one above is surprisingly great. One cannot but wonder, upon comparing the two, why the great electric lighting companies are no richer. The averages under the two systems are instructive. The average price paid to private parties by the various cities is $105.13 per light each year. The same service when performed directly under municipal management averages to the citizens a cost of $52.12½. Under the former method, Boston pays annually the enormous sum of $180 per light, while the greatest cost under public control is $100 paid by Easton, Pa. The lowest amount which corporate greed will take to loose its hold upon the public purse is paid in Cortland, N. Y., to the sum of $50 per light each year. But Ypsilanti, Mich., by supplying herself with nightly illumination, has been able to keep the expense for the same work down to $23.61.

The first and only conclusion to be drawn from a study of these figures is that cities can supply their own electric lighting much more cheaply and advantageously than they can obtain it from private parties. Individual corporations cannot dispose of their product at the same price and retain a reasonable profit. The very fact that an increased number of lights are obtained at a less than proportionate increase of outlay is a strong argument in favor of municipal management. A greater number of lights are made necessary by the natural growth of a city. There is no reason why the sum thus saved, hitherto put into the coffers of private corporations, should not, by being turned into the public treasury, inure to the benefit of the people. Besides, it costs but little more to burn the lamps ten hours than for six. If the lamps burn all night no more linemen nor other employes are required.

Many cities, recognizing the advantages in owning certain enterprises, are manufacturing their own gas; many more are supplying themselves with water. In such places great saving could be effected by running an electric lighting plant in conjunction with the water works. This has been done in Dunkirk, N. Y., and has proven profitable to the city. If desirable, commercial lights might be sold and the revenue thus accruing would lessen the amount necessary to be raised by taxes. In this way the taxpayer would reap some direct benefit from the undertaking.

But it may be argued that various other considerations should be taken into account. Many municipalities stand in greater need of other improvements which demand their entire resources. To these it seems better to postpone the acquisition of an electrical plant and to leave the matter for the present in private hands. The changing condition of the electrical industry, the constant application of new inventions, the probable discovery of new processes, all advise that haste be made slowly. But that does not disprove the advisability of taking measures to obtain, without friction, municipal control of this industry in the near future. Where individuals have already invested their capital in such undertakings, it is always more difficult to bring about the change; for they will take pains to prevent it as long as possible. As long as they can control the primaries and nominating conventions, the corporations are always "out of politics." They are for either party, but above all for themselves. The corruption which might possibly result from the extension of municipal functions to electric lighting and other monopolies of service, is not to be compared with the pernicious influence upon politics of private companies when seeking fat city contracts.

There are frequent complaints under the system of private management. In Scranton, the local company persisted in furnishing a light of less power than that called for in their agreement. Investigation showed that instead of giving a 2,000 c. p. arc light, the lights had never been over 800 c. p. and very seldom that, even under the most favorable circumstances. Very often they had run down to 400 or 500 c. p. The poles were placed in arbitrary positions, and the company failed to supply the lamps at intersections. This last neglect made necessary an increased number of lights, which increase, of course, added to the profit of the company. The dirty condition of the globes furnished another cause for complaint. As far as the wires are concerned, the public is well aware of the threatening danger. Every one acknowledges that the wires ought to be placed underground; but the recent experience in New York city has shown the strength as well as the present humor of the great corporations. Such trouble would be very unlikely to arise if these industries were under public control.

The advantages of public ownership of natural monopolies are beginning to be appreciated. The owners of the electric lighting companies have perceived the trend of public opinion. One of them, in a recent work upon the subject, has enunciated the astounding principle that electric lighting, above all other industries, "is the field for private monopoly." But this proposition is far from being generally accepted. Theory as well as practice points to an opposite direction. At the banquet of the Boston Merchants' Association last winter, the Hon. Seth Low, former Mayor of Brooklyn, and recently installed President of Columbia College, said, during his speech in favor of municipal ownership of these monopolies of service, "that the result of his experience in the Mayor's office for four years had been to change the whole current of his thoughts, which formerly ran away from that conclusion." In view of the general satisfaction expressed by the citizens of those cities operating their own electric lighting plants, one can scarcely fail to agree with the opinion expressed in the report of the Scranton committee to the effect that "the day is rapidly approaching when cities will no longer submit to so barefaced a fleecing process, but will own their respective plants and thus reduce the cost of lighting to a minimum."

MAGNETISM.[1]

BY DR. JOHN HOPKINSON, F. R. S.

As old as any part of electrical science is the knowledge that a needle or bar of steel which has been touched with a loadstone will point to the north. Long before the first experiments of Galvani and Volta the general properties of steel magnets had been observed—how like poles repelled each other, and unlike attracted each other; how the parts of a broken magnet were each complete magnets with a pair of poles. The general character of the earth's magnetism has long been known—that the earth behaves with regard to magnets as though it had two magnetic poles respectively near the rotative poles, and that these poles have a slow secular motion. For many years the earth's magnetism has been the subject of careful study by the most powerful minds. Gauss organized a staff of voluntary observers, and applied his unsurpassed powers of mathematical analysis to obtaining from their results all that could be learned.

The magnetism of iron ships is of so much importance in navigation that a good deal of the time of men of great power has been devoted to its study. It was *the* scientific study of Archibald Smith; and Airy and Thomson have added not a little to our practical knowledge of the disturbance of the compass by the iron of the ship. Sir William Thomson, in addition to much valuable practical work on the compass, and experimental work on magnetism, has given the most complete and elegant mathematical theory of the subject. Of late years the development of the dynamo machine has directed attention to the magnetization of iron from a different point of view, and a very great deal has been done by many workers to ascertain the facts regarding the magnetic properties of iron. The upshot of these many years of study by practical men interested in the mariner's compass or in dynamo machines by theoretical men interested in looking into the nature of things, is that, although we know a great many facts about magnetism, and a great deal about the relation of these facts to each other, we are as ignorant as ever we were as to any reason why the earth is a magnet, as to why its magnetic poles are in slow motion in relation to its substance, or as to why iron, nickel, and cobalt are magnetic, and nothing else, so far as we know, is to any practical extent. In most branches of science the more facts we know the more fully we recognize a continuity, in virtue of which we see the same property running through all the various forms of matter. It is not so in magnetism; here the more we know the more remarkably exceptional does the property appear, the less chance does there seem to be of resolving it into anything else. It seems to me that I cannot better occupy the present occasion than by recalling your attention to, and inviting discussion of, some of those salient properties of magnetism as exhibited by iron, nickel, and cobalt—properties most of them very familiar, but properties which any theory of magnetism must reckon with and explain. We shall not touch on the great subject of the earth as a magnet—though much has been recently done, particularly by Rücker and Thorpe, but deal simply with magnetism as a property of these three bodies, and consider its natural history, and how it varies with the varying condition of the material.

To fix our ideas, let us consider, then, a ring of uniform section of any convenient area and diameter. Let us suppose this ring to be wound with copper wire, the convolutions being insulated. Over the copper wire let us suppose that a second wire is wound, also insulated, the coils of each wire being arranged as are the coils of any ordinary modern transformer. Let us suppose that the ends of the inner coil, which we will call the secondary coil, are connected to a ballistic galvanometer; and that the ends of the outer coil, called the primary, are connected, through a key for reversing the current, with a battery. If the current in the primary coil is reversed, the galvanometer needle is observed to receive a sudden or impulsive deflection, indicating that for a short time an electromotive force has been acting on the secondary coil. If the resistance of the secondary circuit is varied, the sudden deflection of the galvanometer needle varies inversely as the resistance. With constant resistance of the secondary circuit the deflection varies as the number of convolutions in the secondary circuit. If the ring upon which the coils of copper wire are wound is made of wood or glass—or, indeed, of 99 out of every 100 substances which could be proposed—we should find that for a given current in the primary coil the deflection of the galvanometer in the secondary circuit is substantially the same. The ring may be of copper, of gold, of wood, or glass—it may be solid or it may be hollow—it makes no difference in the deflection of the galvanometer. We find, further, that with the vast majority of substances the deflection of the galvanometer in the secondary circuit is proportional to the current in the primary circuit. If, however, the ring be of soft iron, we find that the conditions are enormously different. In the first place, the deflections of the galvanometer are very many times as great as if the ring were made of glass, or copper, or wood. In the second place, the deflections on the galvanometer in the secondary circuit are not proportional to the current in the primary circuit; but as the current in the primary circuit is step by step increased we find that the gal-

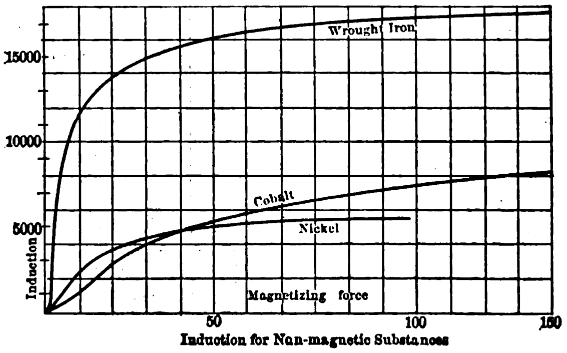

FIG. 1.

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[1] A paper read before the Institution of Electrical Engineers, London.

vanometer deflections increase somewhat, as is illustrated in the accompanying curve, Fig. 1, in which the abscissæ are proportional to the primary current, and the ordinates are proportional to the galvanometer deflections. You observe that as the primary current is increased the galvanometer deflection increases at first at a certain rate; as the primary current attains a certain value the rate at which the deflection increases therewith is rapidly increased, as shown in the upward turn in the curve. This rate of increase is maintained for a time, but only for a time. When the primary current attains a certain value the curve bends downward, indicating that the deflections of the galvanometer are now increasing less rapidly as the primary current is increased; if the primary current be still continually increased, the galvanometer deflections increase less and less rapidly.

Now what I want to particularly impress upon you is the enormous difference which exists between soft iron on the one hand, and ordinary substances on the other. On this diagram I have taken the galvanometer deflections to the same scale for iron, and for such substances as glass or wood. You see that the deflections in the case of glass or wood, to the same scale, are so small as to be absolutely inappreciable, whilst the deflection for iron at one point of the curve is something like 2,000 times as great as for non-magnetic substances. This extraordinary property is possessed by only two other substances besides iron—cobalt and nickel. On the same figure are curves showing on the same scale what would be the deflections for cobalt and nickel, taken from Professor Rowland's paper. You observe that they show the same general characteristics as iron, but in a rather less degree. Still, it is obvious that these substances may be broadly classed with iron in contradistinction to the great mass of other bodies. On the other hand, diamagnetic bodies belong distinctly to the other class. If the deflection with a non-magnetic ring be unity, that with iron, as already stated, may be as much as 2,000; that with bismuth, the most powerful diamagnetic known, is 0.999825—a quantity differing very little from unity. Note, then, the first fact which any theory of magnetism has to explain is: Iron, nickel, and cobalt, all enormously magnetic; other substances practically non-magnetic. A second fact is: With most bodies the action of the primary current on the secondary circuit is strictly proportional to the primary current; with magnetic bodies it is by no means so.

You will observe that the ordinates in these curves, which are proportional to the kicks or elongations of the galvanometer, are called induction, and that the abscissæ are called magnetizing force. Let us see a little more precisely what we mean by the terms, and what are the units of measurement taken. The elongation of the galvanometer measures an impulsive electromotive force—an electromotive force acting for a very short time. Charge a condenser to a known potential, and discharge it through the galvanometer; the needle of the galvanometer will swing aside through a number of divisions proportional to the quantity of electricity in the condenser—that is, to the capacity and the potential. From this we may calculate the quantity of electricity required to give a unit elongation. Multiply this by the actual resistance of the secondary circuit and we have the impulsive electromotive force in volts and seconds, which will, in the particular secondary circuit, give a unit elongation. We must multiply this by 10^8 to have it in absolute C. G. S. units. Now the induction is the impulsive electromotive force in absolute C. G. S. units divided by the number of secondary coils and by the area of section of the ring in square centimeters. The line integral of magnetizing force is the current in the primary in absolute C. G. S. units—that is, one-tenth of the current in amperes—multiplied by 4π. The magnetizing force is the line integral divided by the length of the line over which that line integral is distributed. This is, in truth, not exactly the same for all points of the section of the ring—an imperfection so far as it goes in the ring method of experiment. The absolute electro-magnetic C. G. S. units have been so chosen that if the ring be perfectly non-magnetic the induction is equal to the magnetizing force. We may refer later to the permeability, as Sir William Thomson calls it; it is the ratio of the induction to the magnetizing force causing it, and is usually denoted by μ.

There is a further difference between the limited class of magnetic bodies and the great class which are non-magnetic. To show this, we may suppose our experiment with the ring to be varied in one or other of two or three different ways. To fix our ideas, let us suppose that the secondary coil is collected in one part of the ring, which, provided that the number of turns in the secondary is maintained the same, will make no difference in the result in the galvanometer. Let us suppose, further, that the ring is divided, so that its parts may be plucked from one another, and the secondary coil entirely withdrawn from the ring. If now the primary current have a certain value, and if the ring be plucked apart and the secondary coil withdrawn, we shall find that, whatever be the substance of which the ring is composed, the galvanometer deflection is one-half of what it would have been if the primary current had been reversed. I should perhaps say approximately one-half, as it is not quite strictly the case in some samples of steel, although, broadly speaking, it is one-half. This is natural enough, for the exciting cause is reduced from—let us call it a positive value, to nothing when the secondary coil is withdrawn; it is changed from a positive value to an equal and opposite negative value when the primary current is reversed. Now comes the third characteristic difference between the magnetic bodies and the non-magnetic. Suppose that, instead of plucking the ring apart when the current had a certain value, the current was raised to this value and then gradually diminished to nothing, and that then the ring was plucked apart and the secondary coil withdrawn. If the ring be non-magnetic, we find that there is no deflection of the galvanometer; but, on the other hand, if the ring be of iron, we find a very large deflection, amounting, it may be, to 80 or 90 per cent. of the deflection caused by the withdrawal of the coil when the current had its full value. Whatever be the property that the passing of the primary current has imparted to the iron, it is clear that the iron retains a large part of this property after the current has ceased. We may push the experiment a stage further. Suppose that the current in the primary is raised to a great value, and is then slowly diminished to a smaller value, and that the ring is opened and the secondary coil withdrawn. With most substances we find that the galvanometer deflection is precisely the same as if the current had been simply raised to its final value. It is not so with iron; the galvanometer deflection depends not alone upon the current at the moment of withdrawal, but on the current to which the ring has been previously subjected.

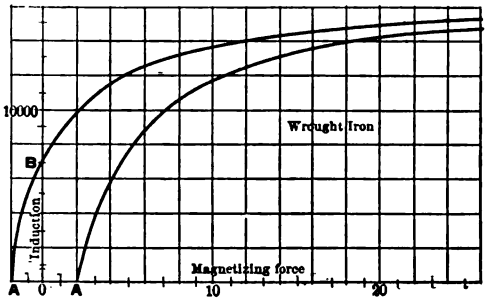


FIG. 2.

We may then draw another curve, Fig. 2, representing the galvanometer deflections produced when the current has been raised to a high value and has been subsequently reduced to a value indicated by the abscissæ. This curve may be properly called a descending curve. In the case of ordinary bodies this curve is a straight line coincident with the straight line of the ascending curve, but for iron it is a curve such as is represented in the diagram. You observe that this curve descends to nothing like zero when the current is reduced to zero; and that when the current is not only diminished to zero, but is reversed, the galvanometer deflection only becomes zero when the reversed current has a substantial value. This property possessed by magnetic bodies of retaining that which is impressed upon them by the primary current has been called by Professor Ewing "hysteresis," or, as similar properties have been observed in quite other connections, "magnetic hysteresis." The name is a good one, and has been adopted. Broadly speaking, the induction as measured by the galvanometer deflection is independent of the time during which the successive currents have acted, and depends only upon their magnitude and order of succession. Some recent experiments of Professor Ewing, however, seem to show a well-marked time effect. There are curious features in these experiments which require more elucidation.

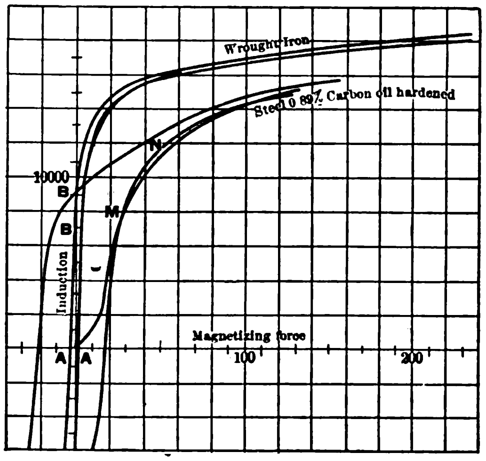


FIG. 3.

It has been pointed out by Warburg, and subsequently by Ewing, that the area of curve 2 is a measure of the quantity of energy expended in changing the magnetism of the mass of iron from that produced by the current in one direction to that produced by the current in the opposite direction and back again. The energy expended with varying amplitude of magnetizing forces has been determined for iron, and also for large magnetizing forces for a considerable variety of samples of steel. Different sorts of iron and steel differ from each other very greatly in this respect. For example, the energy lost in a complete cycle of reversals in a sample of Whitworth's mild steel was about 10,000 ergs per cubic centimeter; in oil-hardened hard steel it was near 100,000, and in tungsten steel it was near 200,000—a range of variation of 20 to 1. It is, of course, of the greatest possible importance to keep this quantity low in the case of armatures of dynamos, and in that of the cores of transformers. If the armature of a dynamo machine be made of good iron, the loss from hysteresis may easily be less than one per cent.; if, however, to take an extreme case, it were made of tungsten steel, it would readily amount to 20 per cent. In the case of transformers and alternate current dynamo machines, where the number of reversals per second is great, the loss of power by hysteresis of the iron, and the consequent heating, become very important. The loss of power by hysteresis increases more rapidly than does the induction. Hence it is not well in such machines to work the iron to anything like the same intensity of induction as is desirable in ordinary continuous current machines. The quantity O A when measured in proper units, as already explained—that is to say, the reversed magnetic force, which just suffices to reduce the induction as measured by the kick on the galvanometer to nothing after the material has been submitted to a very great magnetising force—is called the "coercive force," giving a definite meaning to a term which has long been used in a somewhat indefinite sense. The quantity is really the important one in judging the magnetism of short permanent magnets. The residual magnetism, O B, is then practically of no interest at all; the magnetic moment depends almost entirely upon the coercive force. The range of magnitude is somewhat greater than in the case of the energy dissipated in a complete reversal. For very soft iron the coercive force is 1.6 C. G. S. units; for tungsten steel, the most suitable material for magnets, it is 51 in the same units. A very good guess may be made of the amount of coercive force in a sample of iron or steel by the form of the ascending curve, determined as I described at first. This is readily seen by inspection of Fig. 3, which shows the curves in the cases of wrought iron, and steel containing 0.9 per cent. of carbon. With the wrought iron a rapid ascent of the ascending curve is made, when the magnetizing force is small and the coercive force is small; in the case of the hard steel the ascent of the curve is made with a larger magnetizing current, and the coercive force is large. There is one curious feature shown in the curve for hard steel which may, so far as I know, be observed in all magnetizable substances; the ascending curve twice cuts the descending curve, as at M and N. This peculiarity was, so far as I know, first observed by Professor G. Wiedemann.

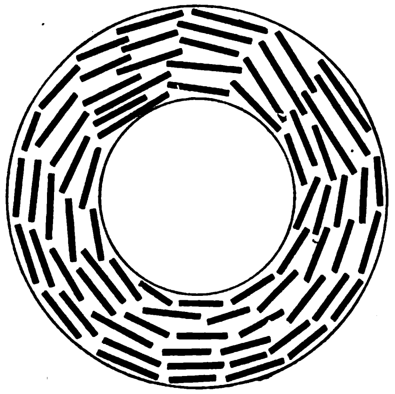


FIG. 4.

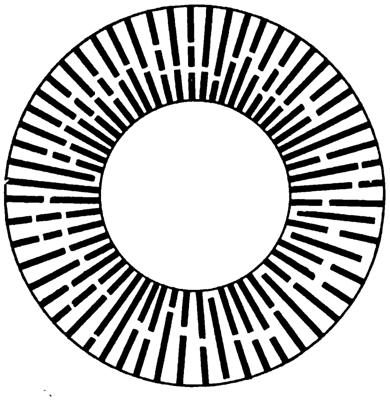


FIG 5.

I have already called emphatic attention to the fact that magnetic substances are enormously magnetic, and that non-magnetic substances are hardly at all magnetic; there is between the two classes no intermediate class. The magnetic property of iron is exceedingly easily destroyed. If iron be alloyed with 12 per cent. of manganese, the kick on the galvanometer which the material will give, if made into a ring, is only about 25 per cent. greater than is the case with the most completely non-magnetic material instead of being some hundreds of times as great, as would be the case with iron. Further, with this manganese steel, the kick on the galvanometer is strictly proportional to the magnetizing current in the primary, and the material shows no sign of hysteresis. In short, all its properties would be fully accounted for if we supposed that manganese steel consisted of a perfectly non-magnetic material, with a small percentage of metallic iron mechanically admixed therewith. Thus the property of non-magnetizability of manganese steel is an excellent proof of the fact—which is also shown by the non-magnetic properties of most compounds of iron—that the property appertains to the molecule, and not to the atom; or, to put it in another way, suppose that we were to imagine manganese steel broken up into small particles; as these particles became smaller there would at length arrive a point at which the iron and the manganese would be entirely separated from each other; when this point is reached the particles of iron are non-magnetic. By the magnetic molecule of the substance we mean the smallest part which has all the magnetic properties of the mass. The magnetic molecule must be big enough to contain its proportion of manganese. In iron, then, we must have a collection of particles of such magnitude that it would be possible for the manganese to enter into each of them, to constitute an element of the magnet. Manganese is, so far as I know, a non magnetic element. Smaller proportions of manganese reduce the magnetic property in a somewhat less degree, the reduction being greater as the quantity of manganese is greater. It appeared very possible that the non-magnetic property of manganese steel was due to the coercive force being very great—that in fact, in all experiments we were still on that part of the magnetization curve below the rapid rise, and that if the steel were submitted to greater forces it would presently prove to be magnetic, like other kinds of steel. Professor Ewing, however, has submitted manganese steel to very great forces indeed, and finds that its magnetism is always proportional to the magnetizing force.

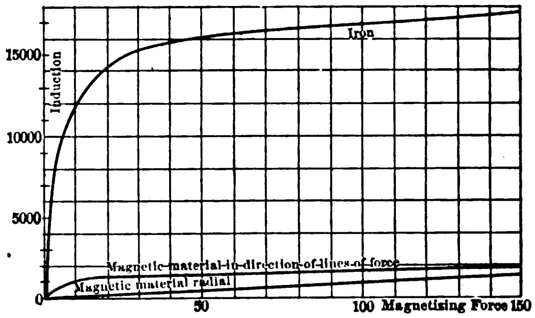


FIG. 6.

No single body is known having the property of capacity for magnetism in a degree which is neither very great nor very small, but intermediate between the two extremes. We can, however, mix magnetic and non-magnetic substances to form bodies apparently intermediate. It is, therefore, interesting to consider what the properties might be of such a mixture. It depends quite as much on the way in which the magnetic part is arranged in the mass, as on its actual quantity. Suppose, for example, it is arranged as in Fig. 4—in threads or plates having a very long axis in the direction of the magnetizing force—we may at once determine the curve of magnetization of the mixture from that of the magnetic substance by dividing the induction for any given force in the ratio of the whole volume to the volume of magnetic substance. If, on the other hand, it is as in Fig. 5—with a very short axis in the direction of the force, and a long axis perpendicular thereto—we can equally construct the curve of magnetization. This is done in Fig. 6, which shows the curve when nine-tenths of the material is highly magnetic iron arranged as in Fig. 5, whilst the other curve of the same figure is that when only one-tenth is magnetic, but arranged as in Fig. 4. You observe how very different is the character of the curve—a difference which is reduced by the much less proportion of magnetic material in the mixture in the one case than in the other. One peculiarity of these arrangements of the two materials in relation to each other is that the resulting material is not isotropic—that is, its properties are not the same in all directions, but depend upon the direction of the magnetizing force in the material. Of course, this is not at all a probable arrangement, but it is instructive in showing the character of the result as depending upon the construction of the material. Let us, however, consider the simplest isotropic arrangement; let us suppose that one material is in the form of spheres bedded in a matrix of the other: if the spheres are placed at random this is clearly an isotropic arrangement. The result is very different according as the matrix or the spheres are of the magnetic material. Suppose that the volume of the spheres is one-half of the whole volume. In Fig. 7, we have approximately the curve for iron, for a mixture of equal quantities of iron and a non-magnetic material, the spheres being non-magnetic and the matrix iron; and for a mixture, the spheres being iron, and the matrix non-magnetic. Observe the great difference. When the spheres are iron the induction is near four times the force for all values of the force. When the matrix is iron the induction is near two-fifths of the induction when the material is iron only.

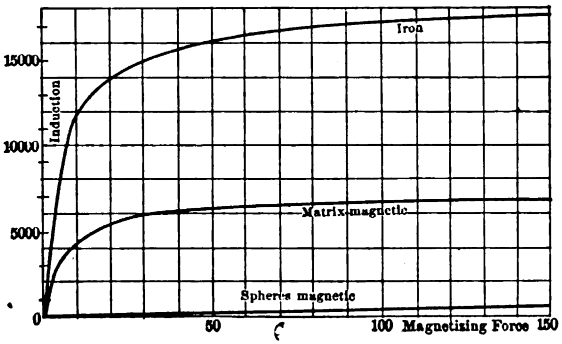


FIG. 7.

(To be continued.)

CORRESPONDENCE.

NEW YORK AND VICINITY.

A Dinner to Col. Gouraud.—A Proposed State Electrical Board.—The Lockport Water Co.'s Electrical Power Scheme.—Trying to Regulate Telephone Rates.—A Meeting of the Subway Board.

AN interesting dinner was given last Thursday by Col. Gouraud to some of his friends of the Grand Army of the Republic, chiefly old comrades in the Third Cavalry, in which he started as a private and ended as a captain, being breveted a colonel for valor in the field. The menu was a very tasteful production, and it is needless to say that the dinner, which was served in the Moorish room at the Hoffman House, was all that could be asked. A large number of electrical people were present. including Genl. E. S. Greeley, Commodore Cheever, E. N. Dickerson, S. S. Moriarty, S. Insull, Mr. Gottschalk, Dr. Archibald, of London, Mr. Evans, of the North American Phonograph Co., and Jesse Seligman, the banker, and other notables. The room was handsomely decorated with English and American flags, and portraits of Sherman and Gladstone adorned the walls. General Greeley made a glowing speech appropriate to the occasion, and other oratory was also enjoyed. There was an extremely good exhibition of the phonograph, including the English bugle calls, and a wonderful imitation, by means of the kettledrum played into it, of Union soldiers on a train passing through a body of Confederate troops, and exchanging volleys with them. The evening passed away most happily. Mr. Edison had been invited but unfortunately could not be present, though he was not forgotten. Col. Gouraud sails for England in a few days.

Mr. Nolan has introduced a bill in the state legislature creating a board of three commissioners to be the State Board of Electrical Control, to be appointed by the governor and confirmed by the senate. One shall hold office for three, one for four, and one five years. One shall be chosen from the party casting the largest number of votes for governor at the last election, and one shall be an electrical expert. After the expiration of the first term, the terms shall be five years. The board shall have a secretary, to be appointed by the governor and confirmed by the senate to serve for five years. If the expert commissioner is from one political party, the secretary must be from another. The secretary shall be the executive officer of the board, and shall receive $4,000 yearly. The annual salary of each commissioner shall be $8,000. The board may appoint an inspector at $3,000 a year. In many respects the bill conforms to Mr. Roesch's Electrical Commission Bill.

The bill allowing the Lockport Water Co. to supply electricity and to take power from the Niagara river was reported last week in the legislature, amended so that the operations of the company are confined to Niagara, Orleans and Erie counties. The company is also to be subject to the general laws of the state and the municipal laws of the cities where it supplies electricity. Mr. Connelly moved to disagree with the report because it was the same as that which the assembly defeated. Mr. Husted said the bill was not killed; it was simply recommitted, and the committee had reported instead the Senate bill. Mr. Andrus suggested that the bill first be printed, and Mr. Connelly agreed.

The members of the Legislature are not quite of one mind as to what people should pay for telephone service, and consequently two bills on the subject have been introduced. One by Mr. Sullivan fixes the charge for telephones in cities of 500,000 inhabitants and over, at not more than $5 per month; in cities of between 100,000 and 500,000 at not more shan $3.75 per month; and in cities of less than 100,000 at $2.75 per month. Mr. Kerrigan came to the front with a bill calculated to worry the telephone people. It provides that in cities having a population of 500,000 and over, the charge for telephones shall not exceed $6 per month; in cities having 100,000 and less than 500,000 population, not more than $3.75 per month, and in cities having less than 100,000 population, a sum not exceeding $2.75 per month. The Assembly Committee on Electricity heard argument last week by Simon Sterne, representing the Telephone Subscribers' Association of New York, on the Clark Telephone Charges Regulation bill. He urged that $80 a year for telephones would give a fair profit to the companies.

The Board of Electrical Control held an important meeting in the mayor's office last week. The decision of the general term of the Supreme Court on the contract with the Standard Subway Co. was brough up, but action was postponed because the order of the Supreme Court had not been settled. Commissioner Gilroy told the board that he had had a conference with the representatives of the electric lighting companies, and he found that every street that he had decided to pave was to have subways laid in it. He said that he would not agree to permit the laying of subways in any street after it was repaved. W. H. Peckham wanted the whole matter postponed. Edward Lauterbach was anxious to have the work on the Edison system done at once, but every other company objected. It was finally decided to put the matter over until Thursday, April 3, and Mayor Grant said that the work on such streets as are to be paved would be ordered on that day. Ex-Commissioner Gibbens made an application on behalf of the Empire and Bay State Telegraph Co. to erect 10 wires on its own line of poles from Yonkers to the Harlem river, where connection will be made with the Western Union Telegraph Co. The application was granted.

Mr. Emil Rathenau, the general director of the Allgemeine Elektricitæts Gesellschaft, or Edison company, of Berlin, is on a visit to this country, quietly making notes and observations on what he sees in progress.

NEW YORK, April 7, 1890.

BOSTON.

The New Telephone Building.—Meeting of the New England Electric Exchange.—Next Dinner of the Boston Electric Club.—Paper by Mr. Wetzler, and Prospective Ladies' Night.—West End Electric Cars and Rapid Transit.—Meeting of the Boston Society of Civil Engineers.—The Massachusetts Legislature and Electric Legislation.

THE new telephone building on Ninth street is rapily appoaching completion, and arrangements can now be made for offices.

The New England Electric Exchange held an examination this week at the rooms of the Boston Electric Club, at which there were about twenty-five applicants examined for competency.

The next dinner of the Boston Electric Club will be held at the Quincy House, on Monday evening, April 14, when Mr. Joseph Wetzler, editor of THE ELECTRICAL ENGINEER, will read a paper on "Electric Railway Evolution." The lecture will be profusely illustrated with stereopticon views. The house and entertainment committee have also arranged for a ladies' evening on Wednesday the 23d inst., and special arrangements are being made to have a few electrical novelties to interest the ladies, among them being the electric piano, the phonograph, and an Edison toy speaking doll.

The subject of rapid transit is still agitating the people of Boston, especially the residents of the suburbs. The electric car is now no novelty in Boston, and up to within a week ago was rapidly becoming the favorite means of travel. A considerable distance can really be covered in an amazingly short space of time, and with the exception of a few chronic "kickers," they meet the approbation of the public. One or two accidents lately, one unfortunately resulting fatally, have given these "kickers" an opportunity to arouse public feeling, and lately an order was passed by the Board of Aldermen restricting the speed of the electric cars to seven miles an hour in the city proper and twelve miles an hour outside. The West End Street Railway Co., however, for reasons best known to themselves, appear to have reduced even that speed in the city to about five or six miles an hour, and now the electric cars are actually a hindrance to the old rapid transit by horse cars. Even the most emphatic kickers now ride in the cars with a weary expression on their face, and will actually walk a block or two to get to a line which is operated by the old reliable horse power. Something will have to be done very soon, whether in the shape of more rapid surface travel or in an elevated railroad franchise, remains to be seen. The new Thomson-Houston electric locomotive, designed to be used in Boston, has been completed, and was successfully tried in Lynn this week. The locomotive weighs in all seven tons, and has four driving wheels each 36 inches in diameter. There are two 20 h. p. motors attached, and in addition to the ordinary wheel brake, the car is fitted with a small one h. p. motor for operating the air brake. The locomotive is capable of attaining a speed of twenty miles an hour.

Rapid transit was also made the subject of an interesting discussion by the members of the Boston Society of Civil Engineers at their monthly meeting, held this week at the American House. In the absence of the president, Vice-President John R. Freeman presided, Mr. S. C. Tinkham acting as secretary. Previous to the general discussing of the subject, Mr. James K. Tilden read an interesting paper upon "Rapid Transit in London and Boston." Mr. Tilden described in detail the workings of the London underground system, and other gentlemen then discussed the rapid transit system as applied to Paris and Berlin.

The legislature is still engaged in the hearing of remonstrants to elevated railways for the city of Boston. Mr. Ball argued against elevated railways in general, declaring that the Supreme Court would pronounce it unconstitutional to take away the rights of the streets of Boston for a new servitude, without compensation, and he prophesied that the court would be appealed to if any of these charters are granted. The committee on mercantile affairs had under consideration the order in regard to amending ch. 382 acts 1887, so that cities of more than 100,000 people may be exempt from the chapter so far as it restricts to one company the business of making and selling electric light. There was also under consideration an order of representative Clark, of Braintree, to strike from sect. 3, same chapter, the provision that "companies organized for the purpose" of going into the electric light business shall be included under the law. Messrs. E. W. Burdett, of Boston, Clark, of Braintree, and Wyman, of Hyde Park, favored a change in the law so as to permit the granting of special privileges.

BOSTON, April 5, 1890.

CHICAGO.

A New Deposition Dynamo.—A Patent Appeals Court.—The Chicago Electric Club.—The Board of Trade and the Telegraph Companies.

FOREE BAIN is just completing a very large dynamo for electrodeposition work. This machine has a capacity of 3,000 amperes delivered at a potential of from four to six volts, such as is suitable for work of this class. The armature conductors, built up of a number of wires in parallel are equivalent in cross section to a rod of 1½ square inches. He is also very busy on a new type of motor which he has just brought out and which combines many novel and interesting features.

Mr. Brown, late chief examiner of the Patent Office in electricity, and a member of the firm of Butterworth, Hall, Brown and Smith, Honoré Building, Chicago, reports that Mr. Butterworth, late Commissioner of Patents, is now working for a Patent Appeal Court to be an appeal from the commissioner and all the circuit and district courts in the United States in patent causes. The jurisdiction of the Supreme Court of the District of Columbia will be repealed by this bill. The salaries of the judges, five in number, are to be $7,500 per year. There will also be a clerk, marshal and reporter as officers of the court. The intention is to make a high-class tribunal which will crystallize and render uniform the decisions in patent matters.

The next regular meeting of the Chicago Electric Club will be held Monday evening, April 7, at the rooms of the club. Mr. J. K. Pumpelly will read a paper entitled, "Storage Batteries to the Rescue." The title is highly suggestive.

The Board of Trade has made one more effort to suppress the bucket shops by abolishing its quotation department. A three-cornered fight has grown out of the war of the Board of Trade on the bucket shops. The telegraph companies have now been drawn into the affair. They struck their first open blow by announcing that hereafter the Board of Trade business will no longer have a special exchange rate to New York, St. Louis, and other cities. This means 15 cents added to every message to and from the board. Heretofore the members on 'Change have had a 25-cent rate to New York and a 20-cent rate to St. Louis, Milwaukee, and other western exchanges. The public at the same time paid 40 cents to New York and 25 cents to the other cities. Now all will pay alike. By the Board of Trade officials this move is regarded as an unfriendly blow. President Baker hints at the organization of a new commercial telegraph company and says that it is a poor time for any company to go before the public as a friend of bucket shops and an enemy of the Board of Trade. At the general office of the Postal company the officials were prompt to say there was nothing of the nature of retaliation against the board in abolishing the special rate. The exchange rate, they said, was made to apply to business done on the floor where the expense of handling dispatches was light. They have no instruments on the floor now, and the rate naturally dies with their removal.

CHICAGO, April 5, 1890.

ST. LOUIS.

City Lighting.—Tests of Arc Lamps.—Electric Railway Development.—An Action for Fraud against a Telegraph Instructor.

THE bill authorizing an extension of time to the Municipal Electric Light and Power Co., which has been hanging over in the House of Delegates for some time, was taken up and amended to read 120 days from January 1, 1890, and was then passed. On the following evening the amended bill reached the council and was promptly passed. The effect of this bill is to remit the fine of $500 per day and to postpone the date for beginning the city lighting until May 1.

The photometric measurements of the Wood and Jenney arc lights of the Municipal Electric Light and Power Co., which were carried out last week by the Supervisor of City Lighting, under the direction of the Board of Public Improvements, has resulted in favor of the Wood lamp. The mammoth plant of this company is now nearing completion, and as all obstacles have been removed, they confidently expect to turn on their 1,800 arc lights on April 15.

Eight electric railroad bills passed the Municipal Assembly just before its annual adjournment. The Lindell Railway Co., and Benton-Bellfountain Co., are authorized to erect overhead wires in the down-town district. This enables them to equip the entire length of their lines with electric power. The Missouri Railroad Co. is authorized to change to electric power throughout its entire length, including a new extension to Forest Park. The Forest Park, Laclede and Fourth Street Railroad Co., which is a branch line of the Missouri Railroad Co., is authorized to change to electric power. The Mound City Street Railway Co. is authorized to change to electric power throughout its entire length.

The Union Depot Railroad is authorized to make extensions on Jefferson avenue and Arsenal street, and to operate these extensions and the main lines connected therewith by electric power. The St. Louis Central and Western Railway Co., a new oganization intended eventually to take over the old Cable and Western Railroad, is authorized to build an extension to Forest Park and to equip with electric power from Twenty-second street westward. Two of the above roads—the Missouri and the Cable and Western have cable divisions in operation, but the success of electric railroads during the past year has brought about a change of heart in the management and they will give electric power a trial.

The St. Louis Railroad Co. is authorized to change its motive power to cable or electric and to lay two additional tracks. On the Seventh street line, the Short double trolley parallel system will be tried. Preparations were being made to cable the main or Broadway line, but since all the other roads have been granted privileges for overhead wires through the down-town district they are about to reconsider electric power for the main line. The liberal action of the Municipal Assembly toward the street car companies indicates that they are wide awake to the advantages of electric street cars and also to the prosperity of the city.

Henry C. Roeth, proprietor of the Union Telegraph Instruction Co., is held for the Grand Jury in the sum of $1,000 for fraud. His mode of procedure was to advertise for young men and women to learn telegraphy and take positions when qualified at salaries from $75 to $175 per month. It is needless to say no one ever qualified for any such position. His case was investigated by the State Labor Commissioner with the above result.

The Westinghouse people have placed two of their new alternating current arc lamps on exhibtion at the power house of the Missouri Electric Light and Power Co. One lamp is also placed on exhibition at the testing grounds of the Municipal Co., corner of Delmar avenue and Sarah street, during the photometric tests of of the Wood and Jenney arc lights.

ST. LOUIS, April 2, 1890.

PITTSBURGH.

A National Labor Union of Electricians.—Electric Railway work.—Street Railway Litigation.

A MOVEMENT is on foot among the employees of the various electric light companies of this city for the formation of a national union of electricians. The causes that brought about this are said to be dissatisfaction of the men with the American Federation of Labor, to which the electricians formerly belonged. A large number of the men met on Sunday, March 23, to perfect the plans for a national organization. An effort will be made to get the co-operation of all organized electrical workers in other cities and to organize unions in all cities and towns, where there are a sufficient number employed. The leaders in the movement claim that the introduction of telephones and electric lights in cities and towns is going on at such a pace that it is not chimerical to predict that there will not be less than 500,000 electrical workers in the United States in 1900. They expect that the census of this year will show 80,000 or more men, who are engaged directly or indirectly in the electric industries. As an argument in favor of this movement it was stated by one of the men interested, that they are often placed in positions where it would be impossible for an outsider to act as arbitrator, and for that reason it is essential that in the event of any difficulty between employees and the companies they should have men among their own number, who might act as judges in the case. The organization will be open to all men employed around and in connection with electric light stations, and the object will be to advance and improve the condition of the members of the organization. There are about 200 men employed as electric workmen in this city and all of them will join the organization. Another meeting will be held within a few days when the arrangements of the organization will be completed and the officers are to be elected.

A syndicate has been organized in this city with the object of buying up all the old-fashioned street car lines throughout the country and then equip them with the electric motor system. The syndicate is composed of Pittsburgh, Philadelphia and Boston capitalists with a capital of $20,000,000 at their disposal. Mr. H. Sellers McKee, the well known Pittsburgh millionaire and Mr. E. H. Clarke, of Drexel, Morgan & Co., Philadelphia, are at the head of the affair.

A corporation, known as the Homestead & Pittsburgh Connecting Railway, has been chartered in Harrisburg a few days ago with a capital stock of $300,000. This is the latest organization in this city incorporated for the purpose of building an electric road. The new line is to be a feeder of the Pittsburgh Traction Road, and it will run from Oakland, this city, to Homestead, a distance of overthree miles Operations on the road are to be commenced immediately.

Three bills in equity were filed in the Pittsburgh court on Saturday, March 28, against the Duquesne Traction Company. This is the corporation which succeeded a few weeks ago in having eleven ordinances passed in its favor in councils, mention of such fact was made in this correspondance at the time. The plaintiff is the Pittsburgh Traction Co., which claims that the Duquesne Traction Co·, is about to construct car lines on streets and avenues, for which the plaintiff already holds the franchises.

PITTSBURGH, April 4, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE LOSSES DUE TO HYSTERESIS IN TRANSFORMERS.

[121.]—In your issue of April 2, in referring to certain remarks made by me at the recent meeting of the American Institute of Electrical Engineers on the subject of hysteresis you make the statement: "It is this constancy of relation that, as Mr. Tesla pointed out * * * may ultimately establish the correctness of the hypothesis advanced, that in reality there is no loss due to hysteresis, and that the changes of magnetization represent a charging and discharging of molecular energy without entailing an actual expenditure of energy."

I do not recollect having made such a statement, and as I was evidently misunderstood, you will greatly oblige me by inserting the following few lines, which express the idea I meant to advance:

Up to the present no satisfactory explanation of the causes of hysteresis has been given. In the most exhaustive and competent treatise on the theory of transformers, by Fleming, static hysteresis is explained by supposing that "the magnetic molecules or molecular magnets, the arrangement of which constitutes magnetization, move stiffly, and the dissipation of energy is the work done in making the necessary magnetic displacement against a sort of magnetic friction." Commonly it is stated that this is a distinct element in the loss of energy in an iron core undergoing magnetic changes entirely independent of any currents generated therein.

Now it is difficult to reconcile these views with our present notions on the constitution of matter generally. The molecules of iron cannot be connected together by anything but elastic forces, since they are separated by an intervening elastic medium through which the forces act; and this being the case is it not reasonable to assume that if a given amount of energy is taken up to bring the molecules out of their original position an equivalent amount of energy should be restored by the molecules reassuming their original positions, as we know is the case in all molecular displacements? We cannot imagine that an appreciable amount of energy should be wasted by the elastically connected molecules swinging back and forth from their original positions, which they must constantly tend to assume, at least within the limit of elasticity, which in all probability is rarely surpassed. The losses cannot be attributed to mere displacement, as this would necessitate the supposition that the molecules are connected rigidly, which is quite unthinkable.

A current cannot act upon the particles unless it acts upon currents in the same, either previously existing or set up by it, and since the particles are held together by elastic forces the losses must be ascribed wholly to the current generated. The remarkable discovery of Ewing that the magnetization is greater on the descent than on the ascent for the same values of the magnetizing force strongly points to the fact that hysteresis is intimately connected with the generation of currents either in the molecules individually or in groups of them through the space intervening. The fact observed accords perfectly with our experience on current induction, for we know that on the descent any current set up must be of the same direction with the inducing current, and, therefore, must join with the same in producing a common effect; whereas, on the ascent the contrary is the case.

Dr. Duncan stated that the ratio of increase of primary and secondary current is constant. This statement is, perhaps, not sufficiently expressive, for not only is the ratio constant but, obviously, the differential effect of primary and secondary is constant. Now any current generated—molecular or Foucault currents in the mass—must be in amount proportionate to the difference of the inductive effect of the primary and secondary, since both currents add algebraically—the ratio of windings duly considered,—and as this difference is constant the loss, if wholly accounted for in this manner, must also be constant. Obviously I mean here the transformers under consideration, that is, those with a closed magnetic circuit, and I venture to say that the above will be more pronounced when the primary and secondary are wound one on top of the other than when they are wound side by side; and generally it will be the more pronounced the closer their inductive relation.

Dr. Duncan's figures also show that the loss is proportionate to the square of the electromotive force. Again this ought to be so, for an increased electromotive force causes a proportionately increased current which, in accordance with the above statements, must entail a loss in the proportion of the square.

Certainly, to account for all the phenomena of hysteresis, effects of mechanical vibration, the behavior of steel and nickel alloy, etc., a number of suppositions must be made; but can it not be assumed that, for instance, in the case of steel and nickel alloys the dissipation of energy is modified by the modified resistance; and to explain the apparent inconsistency of this view we only need to remember that the resistance of a body as a whole is not a measure of the degree of conductivity of the particles of which it is composed.

N. TESLA.

New York City.

.... THOSE who give of their substance to aid in the promotion of science are entitled to hardly less honor than those who devote life and health and strength to the good work.—*Professor Robert H. Thurston.*

.... WE may expect that measurement classes, boldly so called, will readily find endowments; and as an incidental advantage, they may help to extinguish the popular fallacy of college workshops.—*Fleeming Jenkin.*

THE great names in connection with our progress in knowledge as to the real nature of electricity, irrespective of a mere study and extension of its known facts, are Franklin, Cavendish, Faraday and Maxwell.—*Oliver J. Lodge.*

.... WHAT is needed is a continuation of the effort already commenced, of vigorous protest against the tariff laws on the subject [scientific publications and philosophical instruments] as at present existing; laws which obstruct knowledge at its fountain head; which impose onerous burdens on a class which works gratuitously for the public good, and which place our country in a false position among the enlightened nations of the earth.—*Professor Edward D. Cope.*

SOCIETY AND CLUB NEWS.

AMERICAN INSTITUTE OF ELECTICAL ENGINEERS.

The monthly meeting of the American Institute of Electrical Engineers for April was held on the 2d inst. at Columbia College, where Professor Elihu Thomson delivered a lecture on "Some Phenomena of Alternate Current Induction," of which we present an abstract, with some running sketches representing the experiments shown. The lecture was heard and the numerous experiments were witnessed by about 300 members and their friends, and not a few ladies were present. The meeting was presided over by Seth Low, who made a charming speech of welcome, and who at the close expressed the hope that the college would soon have the opportunity of entertaining the Electrical Engineers again.

CHICAGO ELECTRIC CLUB.

On Monday, April 7, Mr. Pumpelly read a paper entitled, "Storage Batteries to the Rescue," before the Chicago Electric Club. The author showed how the accumulator made the consumer of light or power independent of the steam engine to a considerable extent, and how it may be employed to reduce the expenses of operation in many cases. Mr. Pumpelly admitted that there had been troubles in the past with storage batteries, but claimed that their durability was now sufficient to entitle them to recognition as a valuable adjunct to the steam engine and dynamo.

LITERATURE.

Traité Elementaire de l'Energie Electrique. By E. Hospitalier. Vol. I. Paris: *G. Masson,* 1890. 608 pp.

For several years the tendency of physical science has been towards a definite and properly significant terminology. This has involved, especially in the department of heat, the disuse of many time-honored terms. The development of the subject of electricity is so modern that it has not suffered so conspicuously from a mixed and inappropriate set of terms; but even here there is need of some reform. Authors of text-books and reference books have not usually shown sufficient care in promoting the reform, and have besides admitted the simultaneous use of two systems of units. M. Hospitalier has made it fundamental in his work to use a single word for each phenomenon, and to employ as units only those of the C. G. S. system. To be sure he slips occasionally, and speaks of the "*courant de rupture*" or "*extra courant*" and of "courants alternatifs" and again of "courants periodiques," meaning thereby the same thing. But the exceptions serve only to give prominence to his general usage, and his adherence to the C. G. S. system is absolute.

The book may be regarded as a sort of connecting link, on the one hand, between the more elementary books and the elaborate treatises of Maxwell and Mascart and Joubert, and, on the other, between the purely theoretical works of these men and the purely practical of some of the writers for the "Chemisch-technisch Bibliothek." There are many students of electrical engineering in the United States who will find the book as useful as it will be to the students of "L'Ecole de Physique et de Chimie Industrielles de la Ville de Paris."

M. Hospitalier avails himself of the most recent discoveries and views in regard to physical science in general and electricity in particular. The doctrines of the conservation of matter and the conservation of energy are fundamental in his treatment of his subject, and, in fact, influenced the choice of a title for his work. The treatise begins with an explanation of physical quantities and the units based on the C. G. S. system. Had the author tabulated the conclusions of this chapter he would have made it complete. The derived units, given in chapter III., would also be more useful, if for reference, if put into tabular form.

Some explanation of magnetic phenomena is fundamental to the discussion of electric phenomena, and this explanation is cleverly given in the first chapter. None of the discarded theories of magnetism are even mentioned, but the whole subject is logically developed on the basis of "lines of force" and "magnetic field." This simplicity of treatment is characteristic of the whole book which confines itself to explanation consonant with the laws of nature as understood to-day. Why authors of treatises on physics have thought it necessary to give all, or any of, the theories that have been held and abandoned, is hard to comprehend. Surely the method of giving those theories that accord with established principles is more consistent and logical, and is less confusing to the student. In this respect the work before us is successful. The reader is ready for the theory of the nature of electricity when it is briefly expounded, where it belongs, in the concluding chapter.

With the second chapter the author begins the discussion of electricity proper, and from this point on the mathematical theory is developed. Static electricity, dynamic electricity, resistances, various methods of measuring intensity, potential, quantity and capacity are treated with more or less completeness. Electro-chemistry, "*electro-thermie,*" the relations of magnetism and electricity, induction and alternating currents receive due attention. In short the way is thoroughly prepared for the discussion of applications promised in the second volume. The author adheres to the contact theory of the source of electricity, and explains it with remarkable conciseness. Indeed, whether because the French language or the author's style is especially perspicuous, there seems to be scarcely a superfluous word in the explanatory portion of the work. The same conciseness and clearness marks the mathematical discussions. The fundamental demonstrations are unusually well stated. The reader is expected to have some familiarity with the subject, but the evident aim of the author to teach as well as demonstrate is attained. In treating of static electricity the subject in which the author's methods are, perhaps, seen at their best is the theory of condensers.

The introduction to current electricity is easy and natural. The abandonment of what may be called the mixed historical and theoretical method has no better exhibition of its advantages than just here. We are spared the sight of Galvani's struggling frog and are conducted not by the path of the early experimenters but directly to the modern battery. Three short paragraphs serve to introduce us to Ohm's law. And here again the wise method of the author is shown in making the demonstration of that law indirect, the accuracy of the results obtained from measurements based on the law, being taken as proof of its truth.

The early establishment of the identity of the galvanic and magnetic field is useful as well as logical, and makes proper the immediate discussion of the tangent galvanometer. In view of the importance of that instrument it would seem that a little more complete discussion of it would have been appropriate.

The definition of resistance, given without any attempt to describe its effect on the current, is so characteristic of the author as to deserve especial mention. Ohm's law furnishes him with the definition of resistance complete and unassailable, "Le quotient de la difference de potential entre ses extremités par l'intensité du courant qui le traverse." The graphic method of representing variation of resistance with temperatures is adopted. The methods of measuring resistance, are the well-known methods already in vogue. Among the instruments measuring intensity described in the chapter on "*Galvanometrie*" is found the new (1888) universal aperiodique galvanometer of d'Arsonval and Wiedemann. The others are for the most part well known. The 'constant' of a galvanometer is so ill defined ordinarily that M. Hospitalier does a service in giving the three different meanings applied to the word, and adding the significant remark: "To avoid any confusion care should be taken never to use the word 'constant' without accurately defining it in each case."

The chapters on electrometry, generators of electric energy, and the measurement of quantity and capacity, contain descriptions and discussions of several methods of measurement, worthy of a more extended notice than we can give them. The development of expressions for the intensity, pressure and force of alternating currents is a feature of chapter VII. These play an important part in the discussions in the chapter on alternating currents.

The chapter on electro-chemistry, is devoted to the theory of primary batteries (called by the author "piles hydro-electriques"), polarization, electrolysis and secondary batteries. It is unfortunate that M. Hospitalier should give the weight of his name to the word "Accumulators" instead of "Secondary Batteries." The idea of storing up electricity as if it were some form of matter, is so foreign to modern ideas, that there is little reason for the use of a word that implies accumulation, and such phraseology is not in harmony with the rest of the work. The selection of primary batteries for description is judicious. It is a relief, after the bewildering variety that finds place in many books, to find an author who confines himself to the few that are essential. The description of M. Moissau's isolation of fluorine is an interesting addition to the subject of electrolysis, and its introduction is justified by reason of the difficulties that beset the experiment. Under the head of "Electro-thermie," the author includes both the thermal effects of the current and thermo-electricity. Some very recent applications of the thermal effects in instruments of measurement are described here. These are Ayrton and Perry's thermic voltmeter (1887) and Mr. F. J. Smith's ingenious, if not immediately practical, apparatus in which the heat of the current causes water to expand and indicate the amount of current by the amount of expansion.

The subjects treated in the remainder of the book have been greatly developed in the past few years, and the author has shown unusual enterprise in incorporating into his work abstracts of recent articles and new inventions. The electro-dynamic balance of Sir W. Thomson and the ampere standard of M. Pellat, serve to illustrate the application of electro-dynamic laws, and recent contributions on the subject of induction are used to aid in determining co-efficients and constants. The difference in phase between the two alternating currents, primary and secondary, in a transformer is traced to a sluggishness in the magnetization of the iron core. This seems a little strange in view of the experiments of Professor S. P. Thompson and Mr. W. M. Mordey on the alleged magnetic lag in dynamos, and one is inclined to look farther for the explanation of what is undoubtedly a fact. The otherwise excellent chapter on alternating currents is marred by the only imperfect cuts in the book.

This book should have many readers in this country. The number pursuing courses of study in electricity will find it an excellent introduction to Maxwell. It is not intended for beginners, and such should not attempt it; but the more advanced student and the electrical engineer will find it interesting and instructive. He will be pleased with the typography and general make-up of the book, and will follow with pleasure the neat demonstrations.

NEWS AND NOTES.

COLLEGE NOTES.

Harvard University.

Several weeks ago, Mr. C. H. Davis, C. E., of New York, spoke before the Electric Club on "Practical Electrical Engineering." Mr. Davis gave many valuable suggestions in regard to the choice of the proper size of dynamos and engines for an installation, methods of wiring, choice of lamps, switches, etc. The necessity of looking carefully after all the little details of an installation was especially dwelt upon.

The pupils of the Manual Training School gave public exhibitions on Friday evenings in March. There was a large attendance each time. The Harvard contingent distinguished itself as usual. The new Thomson-Houston plant just installed made an excellent showing.

It has been found that if telephone wires are connected to the gas pipes at the Jefferson laboratory, the ticking of the clock at the Harvard Observatory—about two-thirds of a mile distant—can be heard. The sound is rather faint, but it is unmistakeable.

The Electric Club has recently received a number of fine catalogues, among them one bound in morocco and gold, from the Fraser & Chalmers Co. of Chicago. The club is making a special feature of this collection of catalogues, and hopes to have it the finest and most complete in America. It is intended to have represented every dynamo, lamp, engine, boiler, etc., used in two or more central stations anywhere in the United States. In addition there will be catalogues of all kinds of supplies, telegraph and telephone apparatus, etc. The club believes this collection will be very valuable, both to itself, and to the companies represented.

Professor B. O. Pierce has somewhat recovered from his illness, and has gone to the White Mountains to regain his strength.

TELEGRAPHIC FAST SENDING TOURNAMENT.

The National Fast Telegraphing Tournament, organized so ably by Mr. Fred. Catlin, of "Catlin grip" fame, takes place on Thursday afternoon and evening, April 10, at Hardman Hall.

There will be three distinct classes in the tournament, the first being open for all, with three prizes of $100, $70 and $30; the second, also open for all, barring those operators who have made a better record than eleven minutes, with three prizes of $85, $65 and $30. The third is for the ladies' class free for all, with prizes of $50, $40 add $20. A very interesting feature will be an "Old Timers' Class," open to those who were in the service prior to 1865, and in which will be two prizes, $50 and $40. Additional prizes of small amounts will be awarded to the sender and receiver who shall make the cleanest work and the best copy, regardless of speed.

It is expected that all previous records will be broken in the coming tournament. In 1885 J. W. Roloson won the championship with a score of 10m. 32s., Wm. Gibson came second with a score of 500 words in 10m. 57s., and F. H. Kihm third, in 10m. 38s. Although Kihm was speedier than Gibson by a few seconds, the latter's work was slightly better. The 500 words then used contained 2,334 Morse characters, 15 periods and 4 commas, a total of 2,368 characters, or an average of 230 characters to the minute. Mr. W. P. Phillips estimates that the winning speed involved 19 movements of the hand per second.

KINDLY GREETINGS.

The Electrical Engineer, the oldest journal of its class in America, and long and favorably known in its monthly form, is to be converted into a weekly publication from the date of April 1 next. Mr. T. Commerford Martin and Mr. Joseph Wetzler, both well and widely known in connection with electrical journalism, will be connected with the Engineer in its new form, and their names in connection with those of Mr. F. L. Pope and G. M. Phelps are a sufficient warrant of the character of the re-organized journal.—*Engineering News.*

The Electrical Engineer has been published some years as a monthly and has made an excellent reputation as a high-class technical journal. It is now to appear weekly, the first weekly issue to be out April 2. It is the purpose to enlarge the field covered, without lowering the scientific standard of the journal. Mr. T. C. Martin, past president American Institute of Electrical Engineers, and Mr. Joseph Wetzler, one of the Managers of the Institute, have both taken editorial charge. These gentlemen have been for some years editors of the *Electrical World*, and to their excellent, untiring and loyal work very much of its success is due. They will take the same qualities to their new field, and we have no doubt that there, too, they will win success.—*Railroad Gazette.*

The Electrical Engineer is probably the most thoroughly scientific electrical journal published this side the Atlantic, and has become as necessary to the student of electrical matters as some other publications which devote more attention to the electrical news of the hour. Beginning with April 2, it will be changed from a monthly to a weekly issue. T. Commerford Martin, past president of the American Institute of Electrical Engineers, and Joseph Wetzler, both of whom have been identified with the editorial conduct of the *Electrical World*, have retired from that journal, and taken charge of the Engineer. They will enlarge the field covered without lowering the scientific standard of the journal.—*Providence Journal.*

THE MAGNETIC ROTATION OF POLARIZED LIGHT.

In a recent number of the *Philosophical Magazine* H. du Bois describes a valuable research on Kerr's phenomenon, undertaken with the special object of showing the intimate connection between the rotation of the polarized light and the intensity of magnetization of the body at the polished surface of which the light is reflected. Ellipsoidal-shaped specimens of different metals were taken, the end of each being cut off and the surface polished so as to form a mirror. To avoid optical complications the light was always reflected normally on the surface. The amount of rotation produced by reflection was found to be proportioned to the intensity of magnetization when the mirror was cut perpendicularly to the lines of force. When the axis of the mirror was inclined to the lines of force the rotation was proportional to the cosine of the angle of inclination. The verification of this law for five different angles is important, as it has not been done before. Experiments were also made to determine the influence of temperature, with the result that for a range of over 200° C. the ratio between rotation and the magnetic intensity was unaltered for either cobalt, iron or steel. Some slight differences in the case of nickel are easily explained by the fact that the intensity of magnetization just behind the mirror differed from the measured mean intensity of the magnetized body. That the effect depended purely on magnetization, and not on the method by which it was produced, was shown by obtaining the same results when residual magnetism alone was used. The variation of rotation with color was also investigated. The intimate connection between Kerr's phenomenon and Faraday's magnetic rotation is clearly shown by these experiments. The rotation produced is dependent on the intensity of magnetism immediately behind the mirror, and is probably due to the rays of light penetrating a slight distance into the material before the act of reflection is completed.

THE CONDUCTIVITY OF VACUUM.

Dr. James Moser, of the physical laboratory of the Imperial University of Vienna, brought the following interesting facts before a recent meeting of the Imperial Academy of Sciences. A Geissler tube was enclosed in another glass tube connected to a mercury pump and placed near to a powerful indnction coil serving as a source of electrical oscillations, when the following effects were noticed :—1. When the outer tube was at atmospheric pressure, the inner tube was light blue, and the outer one unaffected. 2. This appearance was reversed as soon as the air in the outer tube was sufficiently exhausted; then the inner tube was dark, the outer one becoming conducting and exhibiting a reddish glow.

The question remained, What would happen if the air in the outer tube were still further exhausted? It is known that the discharge of Geissler tubes with electrodes is diminished at a very high vacuum. The cause of this diminution has been much discussed. Some hold the cause to be the non-conductivity of the vacuum; others attribute it to surface resistance at the electrodes. This experiment makes it easy to decide between these two theories, for there can be no question of electrode resistance, as there are no electrodes. The exhaustion was, therefore, carried still farther. The outer tube then again became non-luminous and the inner one glowed as at first. Thus it was shown that the more complete vacuum has no screening effect, and loses its conducting power.

THE TARIFF ON MICA.

Mr. J. S. Moore, the free trade polemic, has a recent letter in the *New York Times*, in which he thus delivers himself with regard to the tariff on mica: "It has been my good luck to receive the controversy of the stovemakers and the mica producers on the coming McKinley Tariff bill. The subject lies in a nutshell. Mica is the crudest kind of a mineral product. It is used by stovemakers as a sort of "fire window" in a stove, and it is still more used now in the electrical manufacture of dynamos and motors. In other words, it is a necessity for actual manufacturing purposes. Unfortunately for the manufacturers who are obliged to use mica, we have a few crazy mica mines in New Hampshire and North Carolina. Hence it is sought to protect the home infant mica mines.

"Mica has always been on the free list, and it is further a peculiar fact that the electrical manufacturers cannot use the infant home-produced mica, even if they were to get it for nothing, whereas, the stovemakers can use the home product. Now, then, it is proposed to tax mica 35 per cent., which will have the effect of taxing the electrical manufacturers 35 per cent. on the use of foreign mica, that they are bound to use, which tax goes into the Treasury, now overflowing with a surplus; and, on the other hand, it will raise the price of home-produced mica 35 per cent., used by the stovemakers, for the benefit of the home producers of mica. This is the innocent little game. True, the tariff swindle on this article is small, but it is so sweet and so ludicrous."

OPERATING TELEPHONE MAGNETOS FROM AN EDISON STATION.

The Chicago Telephone Company now uses commuted Edison current for operating the magneto bells on its lines. A commutator operated by a small water motor is employed to alternate the current. The two brushes of the commuting device are connected with the positive and negative wires of the Edison mains. The neutral wire runs to one segment of the two-part commutator. Between the plug terminal of the neutral wire and the commutator, in series, are the primary coil of a transformer of special design and an incandescent lamp. One end of the secondary coil of the transformer is connected to ground and the other runs to the switch-board in the exchange. As the commutator is kept in motion by a water motor one segment, which is connected with the primary of the transformer, comes alternately into contact with the + and — brush. In this manner the direction of the flow of current in the primary is changed at every revolution. The result is that an alternating current of like character is induced in the secondary coil. As one end of this coil is grounded and the other runs to the switch-board, it is only necessary to press the key to send an alternating current over a line to ring the magneto bells.

OBITUARY.

George D. Allen.

It is with deep regret that we announce the death, on March 28, of Mr. George D. Allen, the well-known and highly-esteemed secretary and general manager of the Excelsior Electric Co. The cause of death was pneumonia, and the news came with staggering suddenness to his associates and friends. Mr. Allen was only 46 years of age and seemed good for many years of hard work. His direct connection with the electrical business was of many years standing. If we are not mistaken, he sold the first Brush machine or plant in this part of the country. He started the Arnoux-Hochhausen Co., and a little later, in August, 1881, with Mr. Hochhausen, formed the Excelsior Electric Co., which is to-day not only one of the oldest corporations in the electric light and power field, but is, after a struggle in which many companies that came into existence later have lost ground or gone out of existence, successful, substantial and progressive. It goes without saying that this state of affairs has been largely due to Mr. Allen's sterling qualities and to the good fortune that attended the company as later changes were made in the personnel of its direction, himself continuing as secretary and general manager throughout.

The funeral services were conducted at Mr. Allen's residence on Washington avenue, Brooklyn, by the Rev. Dr. DeWitt Talmage, and the interment took place in Greenwood cemetery.

Benjamin F. Thurston.

The death of Mr. B. F. Thurston, of Providence, R. I., last month, at the age of 60, removed the leading patent lawyer of the country, and created a deplorable vacancy in the higher ranks of the legal profession. As a consulting lawyer Mr. Thurston was probably without an equal, and of late years his whole work has been done in that capacity. Mr. Thurston was one of the most valued counsel of the Edison company, and not long before his death he had been engaged in working up for them the arguments in connection with the fundamental Edison filament incandescent lamp patents. He was also retained by the Sprague company as consulting lawyer on some of their leading patents; and, in fact, it may be said that he figured in nearly every important electrical litigation of the last decade.

LEGAL NOTES.

INTERFERENCE—STANLEY vs. SLATTERY.

The interference which has been pending for a long time before the Patent Office, between a patent granted to M. M. M. Slattery, of the Fort Wayne Electric Co. and a subsequent application of William Stanley, Jr., of the Westinghouse company, for the method now extensively used of operating converters with alternating currents in multiple arc, has been decided in favor of Stanley on every point. It was established that the invention was made and reduced to practice by Stanley in a full-sized experimental working plant at Great Barrington, Mass., in the spring of 1886, some time before Slattery commenced his experiments.

CHAFFEE vs. TELEPHONE AND TELEGRAPH CONSTRUCTION COMPANY.

In Chaffee *vs.* Telephone and Telegraph Construction Co. Supreme Court of Michigan, it was held that one who erects a building by the side of telegraph and telephone wires, which are on his own land, makes no protest against the maintaining of the wires, allows his tenant in the building to use one of the wires for business purposes, and thus goes on for years, making no complaint whatever, cannot recover of the owner of the wires for losses on the building by fire which might have been averted but for the hindrance to the work of the firemen, occasioned by the wires. This judgment was rendered by a divided bench. Campbell, J. dissenting, said that while delay in complaining might cut off a right to sue in equity, "nothing short of a statutory limitation can bar a suit at law; and where a wrongful entry or intrusion is made without license no license can be legally presumed from inaction. It is not in the power of a city to license any one to damage or encroach on the property of individuals, and no jurisdiction can be based on it."

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 1, 1890.

Alarms and Signals:—*Electric Indicator*, 424,725 and 424,726. *Automatic Fire Alarm*, C. A. Cox and J. F. Cox, 424,860.

Clocks:—*Double-Faced Electric Clock*, E. W. Lindeman, 424,929.

Conductors, Insulators and Conduits:—*Electrical Insulator*, T. S. Reed, 424,575. *Electrical Conductor*, J. A. Barrett, 424,751. *Ventilating System for Electric Subways*, W. Gee, 424,778.

Dynamos and Motors:—*Electric Motor*, Leo Bock, Jr., 424,585. *Regulation of Electric Motors*, S. Bergmann, 424,595. *Electric Motor*, L. T. Smith, 424,734.

Lamps and Appurtenances:—*Marine Electric Light*, A. G. Donelly, 424,544. *Arc Lamp*, R. H. Beach, 424,752. *Arc Light*, J. Dulait, 424,866.

Measurement:—*Method of, and Apparatus for, Measuring Alternating Currents of Electricity*, W. Lowrie, C. J. Hall and H. W. Kolle, 424,891.

Miscellaneous:—*Lightning Arrester*, O. P. Loomis, 424,562 and 424,563. *Choking Electro-Magnet*, L. Gutman, 424,606. *Safety Device for Electric Circuits*, C. G. Young, 424,665. *Electro-Magnet*, G. D. Clarke, 424,703. *Electric Trap*, F. Scherer, 424,729. *Electric Switch*, C. S. Van Nuis, 424,739. *Magnetic Pen-Holder*, E. A. Hill, 424,786. *Electro-Medical Belt*, W. J. Shelton, 424,827. *Electrical Heater*, J. V. Capek, 424,921. *Electrical Cooking-Stove*, J. V. Capek, 424,922.

Railways and Appliances:—*Method of Operating Electric Railways*, R. M. Hunter, 424,607. *Suspended Switch and Travelling Contact for Electric Railways*, C. J. Van Depoele, 424,695. *Electric Locomotive*, J. F. McLaughlin, 424,810. *Electric Railway Motor*, F. A. Perret, 424,818. *Electric Railway*, E. M. Bentley, 424,845. *Electric Railway*, F. O. Blackwell, 424,848. *Electric Railway*, W. H. Knight, 424,887 and 424,888. *Contact Device and Switch for Electric Railways*, C. J. Van Depoele, 424,910. *Electric Railway Motor*, 424,911. *Electric Railway*, R. M. Hunter, 424,928.

Secondary Batteries:—*Electrode for Secondary Batteries*, J. F. McLaughlin 424,809.

Telephones and Appliances:—*Tablet for Telephones*, John B. Morris, 424,493. *Pneumatic Telephone*, J. G. Moreau, 424,684. *Graphophone*, J. H. White, 424,914.

.... ELECTRICITY may possibly be a form of matter—it is not a form of energy. It is quite true that electricity, under pressure or in motion, represents energy, but the same thing is true of water or air, and we do not therefore deny them to be forms of matter.—*Oliver J. Lodge.*

.... SCIENCE has attained a development and a stature and a power that give her the ability to assume her place in the great scheme of civilization. Hereafter she will direct and will lead.—*Professor Robert H. Thurston.*

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

AN OLD SYSTEM REPLACED AT ALLEGHENY, PA.

The managers of the Federal Street and Pleasant Valley Street Railway, of Pittsburgh, Pa., which has been operating twenty-five motor cars on the Sprague electric system for some time, are so well pleased with the operation of the cars on that road that they have ordered an additional equipment of fourteen motor cars. Each of these cars will be equipped with two Sprague improved railway motors. This road now extends in the city of Allegheny, over the line of the early electric railway on University Hill, which used the Bentley-Knight system with underground conduit, and was one of the first installed upon that system. The regular method of overhead contact is now used on this section of the road as well as upon the rest of the line, and the conduit is no longer used. The grades surmounted by the electric cars upon this road are quite severe, being in one place about 12½ per cent., the length of the grade being over a mile.

With the old electrical equipment, this grade was considered too steep to be ascended in the ordinary manner, and at the steepest part a rack was used between the tracks, in which a pinion connected with the motors engaged, in order to secure the necessary traction. With the new equipment this arrangement is found to be unnecessary, and the Sprague cars have no difficulty in ascending the grade with the aid of no other traction than that which the wheels secure from the rails themselves.

There over thirty cars in regular operation upon this railway line.

A THOMSON-HOUSTON MILL TRAMWAY AT LAWRENCE, MASS.

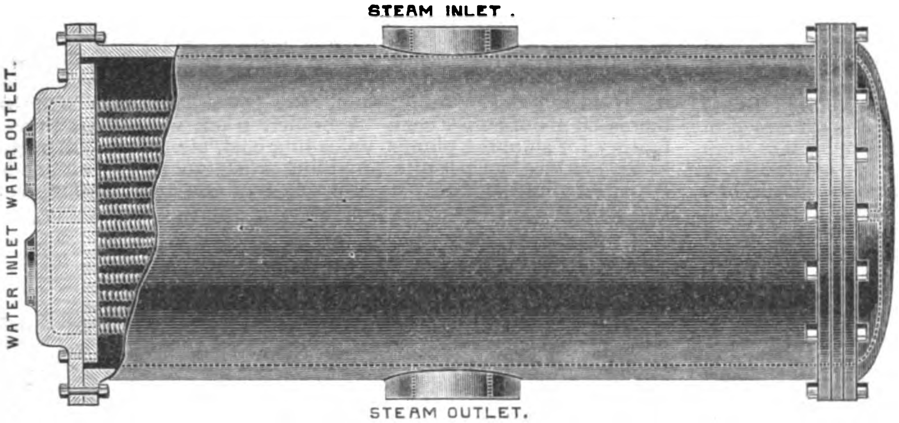
Conclusive proof of the fact that electricity can be used to advantage for mill tramways is evinced in an installation at the Washington Mills, Lawrence, Mass., which has recently been completed by the Thomson-Houston Motor Co. The tramway is used exclusively for carrying coal from the coal pockets to the boiler-room, a distance of about 400 feet. The track is level the entire length, and for the most part straight, there being but two curves; an S-curve just after leaving the coal pockets, and a similar one, though a less sharper turn, where the track enters the boiler-house.

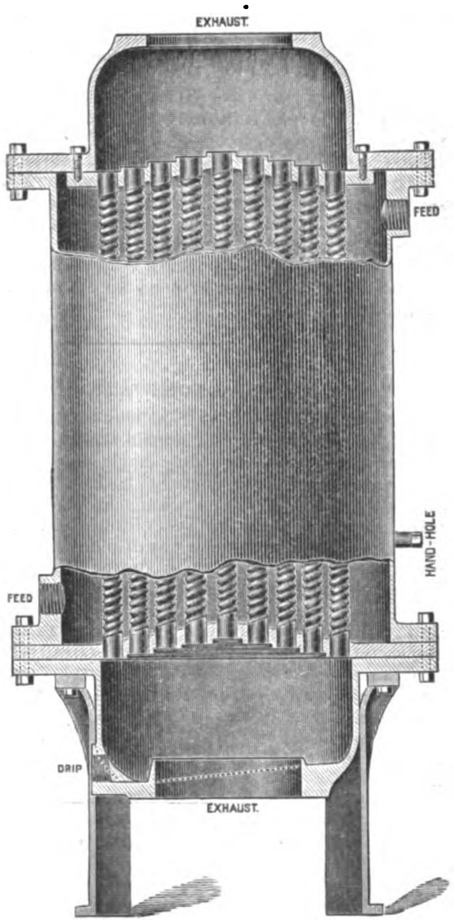
In the electrical construction the overhead system has been used, brackets being employed to support the trolley wire, which runs in height from twelve feet where all is clear, to six feet where the track passes underneath a belt box between two of the mill buildings, the springs on the trolley arm being so adjusted as to maintain an even pressure of the trolley against the conductor irrespective of its height. The current for the operation of the motor car is supplied from a 110 volt dynamo which is used for mill lighting, the rails and a supplementary ground wire being used for the return circuit.

The car equipment consists of one ordinary dump coal car, and one platform car provided with one three h. p. 110 volt series wound motor geared to the car axle, and capable of developing sufficient power to haul a load of 5,000 pounds at a rate of six miles an hour. At one end of the car are placed two levers, one for the special type rheostat used for governing the motor, the other for the reversing switch. Both of these as well as the brake handle are under the immediate control of the operator, who stands upon the platform in front. The floor of the car is made so that it can be readily removed to allow an easy inspection of the motor and appliances, which, though covered with a thick coating of coal dust at all times, have not failed to operate satisfactorily since the tramway was first put in operation.

THE WAINWRIGHT CONDENSER AND FEED-WATER HEATER.

It has now come to be generally recognized that for the economical operation of electric plants, whether for lighting or power purposes, every particle of the available heat in the coal must be utilized. The condenser and the feed-water heater have therefore taken a prominent place in electric central stations, and among the builders of such apparatus who have paid special attention to this department in steam economy are the Wainwright Manufacturing Co., of Boston, Mass. The condenser made by this firm is illustrated in the accompanying engraving, Fig. 1, and embodies the spirally corrugated tube. This entirely overcomes all expansion and contraction, and allows both ends to be made rigid and absolutely tight. The strength of the corrugated tube being three times that of the plain, enables a tube of thinner gauge to be used, which fact, combined with the increase of surface due to the corrugations, and the rotary motion imparted to the water in passing through the tube, renders its efficiency greatly superior to that of the plain tube.





Figs. 1 and 2.—Wainwright Condenser and Feed Water Heater.

The copper tube feed-water heater, also manufactured by the Wainwright Company, is shown in Fig. 2. In this improved heater the water is outside of the tubes, the steam passing through the latter. There is thus afforded a large water space and consequently a comparatively slow passage through the heater, giving the impurities in the water a chance to settle. Another excellent feature of this heater is the method of dripping, the condensed water gravitating around the bottom to the drip opening and out.

Cast iron shells are used on all heaters up to, and including, 300 h. p., which are practically indestructible. Above 300 h. p. steel shells are used. No interior piping whatever is employed in this heater, which can be used horizontally by removing the legs. The heater is guaranteed to deliver the feed-water at a temperature of 200° to 212° Fahrenheit, and to be most carefully constructed.

The Wainwright company also manufacture a variety of other steam appliances, among them being various types of corrugated expansion joints for steam pipes, heaters for compound engines, the Harvard pump regulator, and the Bray & Nickerson automatic water gauge valves.

CARBON DEPOSIT IN A BLAKE TELEPHONE TRANSMITTER.

At a recent meeting of the London Physical Society, Mr. F. B. Hawes read a communication on the above subject and exhibited photographs of the interior portions of a transmitter on which the deposit had taken place. These portions consist of a metal diaphragm, a highly polished carbon button, and a platinum contact piece carried by a german-silver spring placed between them. The diaphragm presented a mottled appearance due to the deposit, but the part which had been behind the german-silver spring seemed comparatively clean. The deposits on the carbon button and german-silver spring were much less dense than that on the exposed parts of the diaphragm, and the space near the point of contact between the platinum and carbon was free from deposit. The deposit was fairly adherent, considerable rubbing being necessary to remove it, and on examination under the microscope particles of copper and metallic crystals could be seen. The author believes the deposit due to some kind of bombardment of carbon particles, but was unable to say why it should occur, or why the varnished diaphragm should receive the greater deposit, although it was further from the carbon than the german silver spring.

In the discussion which followed, Mr. C. V. Boys said the photographs reminded him of a phenomenon he observed some time ago on a glass sheet, against which one terminal of a dry pile had been resting for some weeks. Just as on the carbon button, the glass near the point of contact was clean, and had a comet-shaped deposit formed around it. He could offer no explanation of the appearance.

ARTISTIC ILLUMINATION AT A WEDDING.

One of the principal features of the wedding of Mr. Solomon Frank's daughter at Concordia Opera House, Baltimore, was the electric illumination. The hall was tastefully decorated with house plants. In the centre of the hall, and directly under the main chandelier, were potted plants in the shape of a Maltese cross, which extended up to the chandelier. Among the plants were placed different colored incandescent lamps, in shades and ground glass globes. Around the main chandelier were placed tinted globes representing all kinds of fruit. In each corner of the room there was a pyramid of plants illuminated with colored lights and ground glass globes. The front of the stage was decorated in the same manner. The curtain, behind which the musicians were ensconced, was made entirely of green leaves. It was gracefully draped and had a border composed entirely of incandescent lights. The appearance of the hall was that of a large flower garden on a bright moonlight night. The illumination was carried out by the Electrical Construction Company, Baltimore, C. W. Huntington, manager.

"FIBRONE" AND "PLASTICON."

These are two new insulating materials which have recently been brought out by the Fibrone Manufacturing Co., of 35 Warren street, this city, and which are said to possess high insulating qualities. The "fibrone" is claimed to be a perfect non-conductor and to be absolutely water-proof and proof against the weaker acids; it can be made to withstand any strength of acid, and all action of alkalies, and is, therefore, particularly useful for battery jars and covers. It does not flake off, crack, expand or contract under ordinary temperatures, and for special purposes can be made to withstand a high degree of heat, and can even be made absolutely fire-proof. It may be sawed, planed, drilled, tapped or turned in a lathe, in the same way as hard rubber, and made heavy or light; and also supplied in any color, and in imitation of any natural wood, stone or metal.

This material is intended to take the place of hard rubber, taking a high polish and resembling the latter material very closely.

The company also manufacture all kinds of electrical fittings, of their "plasticon," which may be molded, pressed, cast or turned into any shape. Both materials can be furnished in any form, such as sheets, tubes, rods, bell boxes, rosettes, etc.

ORDERS FOR SHALLENBERGER METERS.

The Westinghouse Electric Co. has received an order for 750 Shallenberger meters of various sizes, which is the largest single order for these instruments that has come to the company since it placed the meters on the market. The order comes from across the Atlantic, it having been placed by the Metropolitan Electric Supply Co., of London, England, which several months ago decided to adopt the Westinghouse alternating current system for use in its large central stations in the great metropolis. Shortly after getting the first machinery started, the London company made a trial of the meters, and, being satisfied with the result, immediately ordered 350 of them. It has now seen fit to supplement the capacity of these 350 by an additional 750 meters, and when the latter order is received in London and put in use, 1,100 meters of the Westinghouse manufacture will be employed there. The Westinghouse Electric Co. is, naturally, more than a little pleased at this evidence of appreciation for their machinery on the part of the English company. The Metropolitan Electric Supply Co., by the way, first ordered 10,000 lights capacity in dynamos from the Westinghouse company and about the first of February last placed a second order, for the purpose of increasing its capacity to 25,000 16-candle power lamps.

WESTINGHOUSE LIGHTING PLANTS.

The Westinghouse Electric Co. reports the following very good showing in central station business for the month of March, 1890: *Incandescent.*—Tampa, Fla., 500 lights, increase; Bluff Point, N. Y., 1,500; Kewanee, Ill., 750; Warren, Ohio, 750; Rochester, Pa., 500; Shelby, N. C., 500; Methuen, Mass., 750; Nashville, Tenn., 3,000, increase; New York, N. Y., 1,500, increase (Mt. Morris Co.); Canton, Mass., 750; New York, N. Y., 15,000, increase (United E. L. & P. Co.); Hoquiam, Wash., 750; Boston, Mass., 3,000, increase; Fort Collins, Col., 750; Girard, Kan., 750; Auburn, Me., 1,500, increase; Wilmerding, Pa., 1,500. Total, 33,750 lights. *Arc.*—Warren, Ohio, 105; Joliet, Ill., 65; Methuen, Mass., 40; Nashville, Tenn., 540; New York, N. Y., 125, increase; Hoquiam, Wash., 50; Cumberland, Md., 45; Girard, Kan., 25; Boston, Mass., 125, increase; Harriman, Tenn., 60; Canton, Mass., 35. Total, 1,215 lights.

A NEW STEAM PUMP FACTORY.

Bids for the new steam pump factory of the Deane Steam Pump Co. will soon be advertised for, as the plans are about finished. The plant is to be located on a lot 200x500 feet. It will consist of five large buildings, with numerous wooden buildings for coal, clay, supplies, etc. The machine shop will be 300x80 feet, with one floor and necessary galleries. The foundry building will also occupy one floor and will be 194x76 feet. The pattern house will be 106x38 feet, and will have three floors. The blacksmith shop, boiler room, engine and testing room will occupy a building 177x34 feet, one floor. An office and storeroom of two stories will be 96x50 feet. It is probable that steam power will be used entirely. The facilities of the Deane company will be increased about 50 per cent. A branch track will be run to the factory for shipping pumps, unloading coal, etc. Work will begin as soon as weather permits, providing satisfactory terms are made with the contractors. The company now employs 235 men, and this number will be largely increased.

AN ELECTRIC MOTOR IN A THEATRE.

A novel and interesting application of electric power has recently been made in New York. In one of the theatres, a spectacular play requires the presentation of a horse race on the stage. In order to keep the race constantly in view of the audience, the platform upon which the horses race is endless, and kept constantly moving over a pair of rollers at each end. When the question of motive power was considered, a Sprague electric stationary motor was selected for the work. This is belted to a system of counter-shafting which reduces the speed to that required by the rollers of the movable platform. This is an example of the varied use to which electric motors are now being applied. When the manufacturers of the Sprague motor made the statement, a year or so ago, that their motors were used in more than 130 different industries, the statement seemed almost incredible, but the convenience of the electric motor and its wide range of adaptability to all classes of work, have made it almost a necessity in places where no other motor could be used.

THE TELEPHONE.

THE town of Hilo, Sandwich Islands, is said to have a more complete and universal telephone service than any town of the same size in Great Britain.

AN ELECTRICAL DRAWBRIDGE AT WILMINGTON, DEL.

An iron drawbridge over the Christiana river in Wilmington, Del., is about to go into service, operated by electricity. The draw is 250 feet long and 34 feet wide, with a roadway and two footways. The total weight is about 200 tons. The motor is by the Thomson-Houston Co., and at a recent test turned the draw completely around in 1¼ minutes. The bridge is lighted with 14 incandescent lights, from the same circuit that supplies the motor. The bridge was designed by Mr. Albert Lucius, of New York, and built by Messrs. Dean & Westbrook, of New York. The total cost, including the motor, was $65,000.

THE SHORT ELECTRIC RAILWAY SYSTEM FOR ROCHESTER, N. Y.

The H. Sellers McKee syndicate, which controls the entire Rochester, N. Y., system of street railways, has just let an immense contract to the Short Electric Railway Co., of Cleveland, Ohio. The contract calls for 100 cars with double motors and 1,100-h. p. generators. Sixty-eight miles will be covered by the system. It is one of the largest contracts ever let for an electric railway system and amounts to $360,000. The contract for the Johnstown Electric Street Railway Co. was let on Monday to the same company. Ten miles will be covered and ten cars have been ordered.

SILK TOWELS FOR DYNAMOS AND MOTORS.

The Royal Silk Manufacturing Co., 2 and 4 Stone street, are manufacturers of non-combustible silk machine toweling, which is specially intended to replace cotton waste, rags, etc., in cleaning machinery. These silk towels are not combustible, even when hot and oily, and a great feature is that they can be washed thirty or forty times. They have great absorbing powers. Practically they are 50 per cent. cheaper than waste. They ought to find great favor for dynamo and motor work.

THOMSON-HOUSTON WESTERN BUSINESS.

The following is a list of the sales of apparatus of the Chicago office of the Thomson-Houston Electric Co., for the month of March, 1890.

ARC.—Fort Smith Gas Lt. Co., Fort Smith Ark., 35 lts; Freeport Elec. Lt. Co., Freeport Ill., 50 lts; John Featherstone & Son, Chicago, Ill., 20 lts.; Osceola Gravel Mining Co., Osceola, Nev., 3 lts; University of Notre Dame, South Bend, Ind., 12 lts; Manitou Elec. Lt. Co., Manitou, Col., 3 lts; A. W. Wright, Alma, Mich., 30 lts; Freeport Elec. Lt. Co., Freeport, Ill., 50 lts; B. F. Draper, Ligonier, Ind., 50 lts; Mt. Clemens Elec. Lt. Co., Mt. Clemens, Mich., 30 lts; Laredo Improvement Co., Laredo, Tex., 50 lts; Laredo Improvement Co., Laredo, Tex., 50 lts.

INCANDESCENT.—Auburn Mining Co., Auburn, Ind., 300 lts., alternating; John Kranz, Chicago, Ill., 300 lts., direct; W. C. Clark,, Chicago, Ill., 300 lts., direct; Manitou, Elec. Light Company, Manitou, Col., 300 lts., direct; A. W. Wright, Alma, Mich., 650 lts., alternating; G. F. Culmer, & Bro., Salt Lake City, Utah, 150 lts., direct; Laredo Improvement Co., Laredo, Tex., 1,300 lts., alternaitng; National Electric Construction Co, Chicago, Ill., 300 lts., direct.

MOTORS.—American Press Asso., Omaha, Neb., 5 h. p. Motor; J. T. Robinson, Notion Co., Omaha, Neb., 5 h. p. Motor.

THE SPRAGUE EQUIPMENT COMPANY.

The Sprague Equipment Co., the Rialto, Chicago, in their fine new offices have on exhibition a large 440 volt Sprague motor for mining purposes, located in the entrance corridor and close by is placed an Edison generator of latest type. A handsome board of antique oak with billiard cloth centre containing samples of all the latest overhead railway appliances, including a new and improved trolley wire insulator, overhead circuit breakers, pull-off brackets, centre curve insulators, improved trolley wheel and a special raw-hide pinion, also attracts much attention. Last but by no means least is Mr. J. L. Barclay's "Electric Extravaganza" consisting of an elegantly finished antique bronze fireplace set in handsome tile work, containing a number of incandescent lamps with ruby globes embedded in cut glass prisms. This is situated in Mr. Barclay's private office, and is quite a work of art and beauty.

The Sprague Company have just completed the equipment of the Sioux City Street Railway Company's line in Sioux City, Ia., with 25 cars over 15 miles of track. The following telegram signed by James F. Peavey, President of the road has just been received "Started trial car yesterday. Run most satisfactory. We are very much pleased," and further in a letter he says "I am more than pleased with our construction all the way through, which is of such a character that all connected with the Sprague Equipment Co., can point to it with much pride. Our citizens are very enthusiatic."

HOLMES, BOOTH & HAYDENS.

MR. H. P. LUCAS, of the above house, has accepted a position as assistant treasurer and purchasing agent with the Northwestern Electric Construction and Supply Co. of St. Paul. Mr. Lafayette Cole, secretary and manager of the Peoria, Ill., Electric Light & Power Co., has resigned and accepted a position as salesman with Holmes, Booth & Haydens, in the place of Mr. Lucas.

WALWORTH STEEL AND IRON POLES FOR ELECTRIC RAILWAYS.

The Walworth Manufacturing Co., of Boston, are in receipt of some very large orders for their well-known iron and steel poles for electric railways. Among them are orders from the Lindell Railway Co., of St. Louis, for 886 centre bracket poles, extra strong, having butts 8 inches in diameter. These poles are the heaviest ever made for that purpose, and are designed so that a runaway team or fire engine coming in contact with them will have no damaging effect. The St. Paul City Railway Co. have also ordered about 1,000 poles, Minneapolis Street Railway Co., 600 poles, and the United Electric Railway, of Nashville, Tenn., 480 poles. Altogether the Walworth company have orders on their books for over $80,000 worth of poles, and are preparing for a very heavy year's business.

OPENING OF THE WOMAN'S EXCHANGE ELECTRICAL EXHIBITION.

The above exhibition, including Mr. Edison's famous Paris Exposition collection of inventions, was opened at the Lenox Lyceum on April 7, by Mr. F. R. Coudert, and by Professor C. F. Brackett, who made an address on the subject of electricity. The exhibition embraces many novel features, and will probably be a great attraction. It will continue until May 15, and is open afternoon and evening, Sundays excepted.

Among the special exhibits are a beautiful central tower of incandescent lights, with streamers; a magnificent telephone exhibit by the telephone companies, so that various operatic performances going on in the city can be heard; long distance telephone lines, one of which brings the roar of Niagara into New York city for the first time; a phonographic dolls' theatre; "A Peep Into the Twentieth Century;" an electric railway, and a number of phonographs. These, and many other novelties are supplemented admirably by the great exhibit of Edison's inventions.

Mr. A. B. De Frece, the manager, is to be congratulated on his success in bringing so fine an electrical exhibition together.

NOTES FROM GERMANY.

However much Germany may in general be behind America in her application of the electric light, a notable exception must be made of Berlin. While the built up portion of the city is fairly well lighted, the principal street, the beautiful "Unter den Linden" is at night almost literally as bright as day. This street, 1,000 meters long and 60 wide, is furnished with three rows of electric lamps, two along the sides and one in the middle between the lindens. Berlin can now hold its own with any city in America as regards completeness of its central station, excellence of its arc lamps (Siemens), and thoroughness of its illumination at night.

BIDS FOR NEW YORK STREET LIGHTING.

Bids for gas and electric lighting for the city for another year were opened April 7 by the Gas Commission at the Department of Public Works. Mayor Grant, Comptroller Myers and Commissioner Gilroy, composing the commission, were all present.

The bids of the electric light companies, when opened, exhibited a uniform advance in the prices demanded over last year. Representatives of the companies present declared that the increase was made necessary by the increased cost to them of the subway system of conduits. The United States company bid for 314 lamps at 39, 41 and 42 cents, respectively, per night each. The Brush company, for 337 lamps, asked the same prices. For 175 lamps the Mount Morris company asked for part 39 cents and for others 42 cents. The Harlem Lighting company wanted 39 cents per night for 166 street lamps and 50 cents for 19 lamps in Mount Morris Park. The East River company asked 42½ cents for 226 lamps.

The total number of lamps bid on is 1,237, or 109 less than last year, the cutting down of the wires having removed that many. The prices are about 15 per cent. higher than those of last year. The bids were referred to Secretary McCormick to tabulate and report on.

WOODHOUSE & RAWSON UNITED, L'TD.

Owing to the rapid increase in the importance of their South African trade, the above company have decided to open a branch warehouse and showroom in Johannesburg, which will be under the management of Mr. R. Lewis Cousens, M.I.E.E., late electrician to the Kimberley Town Council, who is thoroughly acquainted with the requirements of the South African States, and who will have the assistance of a competent staff. Special attention will be paid to the carrying out of such work as the lighting of cities, hotels, mines, docks, railways, etc., the transmission of power for running stamps, tramways, light railways, telpher transport, etc., while it is intended that the depot itself shall be stocked with a most complete assortment of engineering and electrical requisites of the very latest types, and manufactured with a view to the special requirements of the country. A detailed telegraphic code has been arranged with the head office in London, and in the event of any goods being ordered which do not happen to be in stock or on their way, they can be cabled for and shipped within a fortnight.

MANUFACTURING AND TRADE NOTES.

The Westinghouse Electric Co. has recently been awarded the contract for a 3,000 light plant, of the alternating current system, in Lexington, Ky.

The Phœnix Glass Company report an excellent demand for electric lighting glass ware, and Mr. A. H. Patterson finds business opening up in good shape for the season ahead.

Gas Fixture Combination.—The well-known and substantial concerns, Archer & Pancoast Manufacturing Company, and Oxley, Giddings & Enos, have consolidated their electrical and gas fixture business.

The Central Electric Co., 116 and 118 Franklin street, Chicago, are very busy shipping supplies to all parts of the country. Okonite is in specially large demand. In pins and brackets, which they manufacture very largely, business is very lively.

Mr. P. C. Burns, of St. Louis, has been a reent visitor in New York, and reports the Findlay Glass and Carbon Co. as being busy making porcelain cut-outs and cut-out rosettes for electric lighting purposes, in addition to their regular line of carbon batteries, jars, insulators, etc.

The Wheelock Engine Co., Worcester, is now located in its new factory building at South Worcester. The steady increase of business has compelled the erection of this fine structure. An unusually well constructed engine shop has been put up, being light, airy and convenient.

The Pumpelly Storage Battery and Electric Motor Co., Chicago, are meeting with great success with their cells and are filling large orders right along for the sub-companies of the North American Phonograph Co., They have just shipped 100 cells to San Francisco, where the local company are already using several hundred.

George Cutter, 80 Adams street, Chicago, the Western agent of the Bernstein Electric Co., has been making a short business trip in the East. He expects to do a large business in the new constant potential lamp for incandescent lighting, which that company has recently placed upon the market. The demand for his other specialties, especially the combination tin shade, is very brisk.

Lowell Wrench Co.—The lag screw wrench recently introduced by the Lowell Wrench Co., of Worcester, Mass., is meeting with great favor with electric lighting people everywhere. The merits of the wrench itself, combined with the push of the management, have induced a sale that has already exhausted a number of sizes, and the company for a few days found it impossible to fill all their orders.

The Economic Electric Light and Power Co. are making rapid progress with the transition of Reed Brothers' factory at Brockton, into a factory for the manufacture of dynamos, motors, lamps, and all kinds of electric supplies. Within a few days they will commence operations, and will also have a dynamo and incandescent plant in operation in Houghton & Dutton's store in Boston for exhibition purposes.

Mr. Wm. D. McQuesten was a caller last week at our Western office. He is interested in a railroad deal at Aurora, Ill., whereby the old company is to be purchased and re-organized under a new franchise. Fifteen miles of new road will be built and equipped with 25 cars. Aurora is one of the most active Western manufacturing towns and is directly tributary to Chicago. Mr. McQuesten is going to St. Louis, then to Boston and back to New York.

Among the contracts for alternating current apparatus for central station lighting obtained by The Westinghouse Electric Co. during the first two weeks of February are noticed the following: Williamsport, Pa., 750 lights, increase; Butte, Mont., 750 lights, increase; Fort Worth, Texas, 850 lights, increase; Sioux Falls, Dakota, 750 lights; Pineville, Ky, 500 lights; Lexington, Ky., 3000 lights; Creston, Iowa, 750 lights; Shidznoka, Japan, 1,500 lights.

The Southern Electric Co., of Baltimore (Messrs. J. Frank Morrison and Howard Tuxworth), have just secured a charter from the Maryland legislature giving them full power to erect, equip and maintain electric circuits, either ærial underground, or both. The sudden meeting of the stockholders of the Brush Electric Co. of Baltimore, immediately after the granting of this charter, has given rise to various opinions as to what the Southern Electric Co. propose to do.

Brown & Sharpe Manufacturing Co., Providence, R. I., have sent us their neat and compact little pamphlet of "Catalogues and Price Lists" dealing with their machinery, tools and castings, and those of Darling, Brown & Sharpe, manufacturers of U. S. standard rules, cast-steel try squares, standard wire gauges, special appliances of precise measurement, etc. The 200-page pamphlet is a Liebig's extract of American mechanical and engineering skill and experience.

Thackara Mfg. Co.—The appearance of the exhibition rooms of the Thackara Mfg. Co., in their new quarters at 1524 to 1526 Chestnut street, Philadelphia, can be truly said to be a credit to that city. The walls throughout the building are covered with a rich dark material against which the various designs of gas and electric fixtures show off to great advantage. Floor above floor is laden with the richest work in their line, and the whole being lighted by a new incandescent reflector of recent conception makes an appearance truly artistic.

An Alternating Current Plant for Japan.—The first central station electric light plant on the alternating current system for Japan, is about to be established. A corporation of Japanese capitalists in Tokio, has awarded the contract for the apparatus to The Westinghouse Electric Co., of Pittsburgh, Pa., and the machinery, consisting of two 750-light dynamos, exciters, lamps, sockets, switches, cut-outs, etc., will be shipped immediately. The company which purchases this apparatus is also engaged in the installation of a lighting plant for the city of Canton, China.

The Baldwin Locomotive Works, of Philadelphia, made a continuous test of one week's run on a Westinghouse compound engine of 65 h. p. The engine was non-condensing, and was supplied from an independent boiler, and was loaded to about 75 h. p. The gross coal fired under the boiler during the week's run averaged 2.4 pounds per h. p. per hour, which result is an extraordinary performance. This company already had two of the Westinghouse compound engines in their works, and on the strength of the above performance, have placed an order for a third 200 h. p.

The eighth edition of "The Electrician" Electrical Trades Directory and Hand-Book, London, has recently been issued in familiar shape. This useful annual compilation, familiar to many in the United States, comprises carefully prepared lists of corporations, firms and individuals engaged in electrical industries in all parts of the world, whether as engineers, contractors, manufacturers or dealers. In addition to useful tables pertaining to electrical engineering, the new edition has a biographical section, giving some information of eminent men connected with the rise and growth of electrical application, with several portraits.

Lewisohn Brothers, 81 and 83 Fulton street, are the sole agents for M. A. and Arizona copper, and have become well known to the electrical trades for their pure lake copper wire, and copper in other forms for manufacturing purposes. They have recently issued a sumptuous special "perpetual calendar" in leather and ivory, which is of the neatest and daintiest character imaginable. At the top of the dial are perched three birds in a spray of flowers. The dates are movable by knobs at the back, and a steel finger indicates the day of the month. It is, in fact, the costliest trade calendar of the season, and is beautiful enough to grace a boudoir.

Mr. W. M. Donaldson, a very enterprising electrical engineer of Baltimore, has recently entered into the business of distributing electrical energy by means of storage batteries in connection with small motors for household and office use in the cities of Baltimore and Washington. In Baltimore, his batteries are charged by the arc light wires, and in Washington by a Perret dynamo. Mr. Donaldson's business seems to prosper, judging by his recent order on the Elektron Manufacturing Co. for 40 Perret motors for graphophone work. After a series of practical tests Mr. Donaldson has adopted the Perret motor for his work. In some recent tests with this motor on graphophone work, using two volt battery, when recording, the motor took 2.3 amperes, and when reproducing, 2 amperes. With the ordinary 100 ampere-hour storage cell, the motor will drive the graphophone from 45 to 50 hours continuously, which lasts an ordinary business man one month, the battery being then replaced by a freshly charged one and the discharged battery taken to the charging station.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

New England Editor and Manager, A. C. SHAW, Boston, Mass.
Western Manager, W. F. COLLINS, Chicago, Ill

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada.	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. IX. NEW YORK, APRIL 16, 1890. No. 102

Electricity is subject to laws as definite and invariable as those which govern the mechanical motions of the planetary system.—Joseph Henry.

ELECTRIC MUTUAL STATION INSURANCE.

INSURANCE is a very important item to the manager of an electric light or power plant, and has proved a source of considerable trouble and worry. It must therefore be with feelings of pleasure and welcome that central station superintendents hail the debut of the Electric Mutual Insurance Co.. of Boston, with such men as Mr. S. E. Barton and Captain William Brophy at the guiding reins. That all should understand better for what purpose this company has been organized, we quote its own words and claims:—

> Organized for the purpose of insuring *Buildings, Machinery, and Apparatus* used in the manufacture of *Electric Light and Power.*
>
> Insures against *Loss or Damage by Fire* on *Central Stations: Building and Contents* under "*Blanket Form.*"
>
> Examines stations, upon application, and suggests improvements necessary to secure minimum rates.
>
> Employs skilled electrical inspectors who periodically inspect all stations insured by the Company, in order to reduce the fire hazard.
>
> Pays no commissions to brokers.
>
> Furnishes insurance at *cost* by returning all profits to assured at expiration of policies.
>
> Also insures against loss or damage by fire on all overhead lines, lamps and all other apparatus on the circuits outside of the station, under "Blanket Form" of policy.

It is well to draw special attention to the fact that this company is to be operated upon mutual insurance principles, that is, that every policy holder really becomes a stockholder in the Company in direct proportion to the amount of his premium. All stock insurance companies are organized with a certain amount of capital, and are in the business to make as much profit as possible, the less the liabilities being the greater the profits. With the mutual system, no profit is desired, as the difference between the total amount of premiums paid in, and the expenses (including salaries, sundries, and losses by fire) paid out, goes either to swell the surplus account or to be returned in the shape of dividends to the various policy holders. A mutual company has also no commissions to pay to agents or brokers, a very important factor in the running expenses when it is known that such agents for stock companies receive 25 per cent. commission. There is a large advantage also to the station manager, in the fact that the inspections are made by men trained in the electric light business who know what to propose for the elimination of danger, and who will accept no risk until suitable attention to fire protection is paid.

The Mutual system presents so many advantages in the hands of an able and experienced management that success is bound to attend, if only for the reason that every station is distinctly benefited by being insured in it, as soon as the managers fully grasp the whole inwardness of the scheme. Elswhere we print the requirements of the Electric Mutual Insurance Company for the erection and maintenance of a standard station, and we believe that the conditions are such as to arouse not only universal interest but general commendation. They will lead the way to the good, honest work of the future.

ELECTRIC TRAMWAY DATA.

THE introduction of a radical change in any long-established industry or practice is generally a slow one, for although the improvement contemplated may be perfectly apparent from calculations, business men, as a rule, prefer to wait until the correctness of such calculations have been borne out by the actual experience of their more daring fellows. In other words, the establishment of actual working data at once places a new enterprise in a favorable position for commercial exploitation. The electric railway may be said to have been a marked exception to this rule, in that its many inherent methods gained for it a hearing and acceptance long before the actual cost of its operation was clearly ascertained. By this remark it is not intended to convey the impression that those who adopted the electric railway did so on the mere assurance of success given them by the promotors of such systems, but it is worthy of emphasis that the immense development of electric railroading in this country, until recently, has been due as much to the faith of the street railway proprietors in its advantages as to any positive data for comparison. Indeed there can be no other explanation given for the existence of the large number of electric railroads at present in operation in this country,—and for the scarcity of them abroad. But this condition of affairs regarding the actual cost of operation of electric railways is fast disappearing, and we are even now in possession of data upon which reliable calculations can be based. Among the first of these we may mention the tests of Mr. O. T. Crosby, who reduced the expenses of operation to the cost per car-mile, and showed the relation of the various items which go to make up the total, including coal, attendance, real estate, machinery and line, oil and waste. These figures gave as an average 5.09 cents per car-mile for the roads in Washington, Richmond, Cleveland and Scranton. In this issue we print a most instructive analysis of the same subject, by Dr. Cary T. Hutchinson, in which are tabulated the results of a series of experiments made on a number of lines in different cities. The conclusions carried out by Dr. Hutchinson are in the main quite similar to those of Mr. Crosby, and though no actual figures are given as to the cost of operation, the relations which the various items bear to one another are of sufficient value in themselves. Some of the results obtained are highly instructive, and their application by those operating electric roads will lead to increased economy. Thus we would refer especially to the ratio of power required respectively to operate a single car and a motor car with tow. The average increase for the latter is only 33 per cent., and though the item of generating power is shown to be but 19 per cent. of the total cost of operation, attention to this item will produce additional saving. Another important and apparently anomalous fact brought out in this connection by Dr. Hutchinson's figures is, that doubling the number of cars on the line would increase but very little the cost of generating power. Lack of space prevents a more extended reference to this valuable data, but we cannot leave the subject without a passing criticism of the enormously heavy current, aggregating 80 amperes, which experience shows is taken by the motors on starting the cars. In other words, energy corresponding to 50 h. p. and more is frequently passed through the motors to bring the car from rest to motion. The strain which such a sudden development of energy must put upon a pair of motors designed to develop but half that amount cannot but be detrimental, and it speaks well for the excellence of the present construction that it successfully withstands such strains. The remedy for this evidently lies close at hand.

Copper Duties.

THE Committee on Ways and Means evidently fear that the production of copper in this country is not yet a sufficiently adult or robust industry to go alone. The McKinley tariff bill, however, assumes at least the attainment of a period of adolescence in the life of that industry by proposing a partial withdrawal of protection. The framers of the bill perhaps deem copper mining and smelting to have reached a stage of half-growth, and accordingly would cut the existing duty of four cents a pound in two, in the middle. The bill provides as follows: "Copper in plates, bars, ingots, Chili or other pigs and in other forms, not manufactured, not specially enumerated or provided for in this act, two cents per pound." A similar reduction of a moiety in existing rates on copper ores, regulus and old copper is proposed in the bill, while present rates on sheets, wire, rods and other forms of manufactured copper are retained. We do not imagine any considerable amount of grief on the part of copper miners and smelters over the proposed reduction of duty on unmanufactured copper. If they see in it any restriction tending to limit future operations in the way of combinations to control prices, they may find an offset in the meritorious provision of the McKinley bill which would permit metallurgical works to become bonded warehouses and to enter ores of dutiable metals free for treatment and subsequent export of the product, instead of paying duty on entry and getting a refund less 10 per cent. on exporting the product. Meantime it is far from certain that the McKinley bill, or anything closely resembling it, will be enacted before the adjournment of Congress. Its inconsistencies, its failure to deal adequately with the wide spreading desire for free raw materials, in short, its general insufficiency as a measure of revenue reform, evoke criticism and dissatisfaction in so many and such diverse quarters, that members of the House of Representatives are likely to find themselves in a quandary in handling it.

Effect of Current on Traction.

THE interesting record of the results obtained by Mr. O. T. Crosby on the influence of the current in increasing the adhesion between wheel and rail, which appeared in our last issue, has called forth a communication from Mr. Leo Daft, one of the pioneers in electric railroading, and the one who first drew attention to the action investigated by Mr. Crosby. Mr. Daft, it will be noted, coincides in the opinion expressed by us that the method of skidding employed by Mr. Crosby is not a wholly reliable one for this particular purpose, but he agrees in the main with Mr. Crosby as to his conclusions, so far as the present system of electric railroading is concerned. Mr. Daft's original experiments were made with heavy currents passing between wheel and rail, and their effect on the tractive adhesion between the two was unmistakable. But with the modern railway in which higher potentials and smaller currents are employed, Mr. Daft agrees that the effects are probably inappreciable. The point is, however, very interesting, and will bear further investigation.

An Electric Railway List.

We publish in this issue through the courtesy of the Thomson-Houston Electric Co., a complete list of their roads installed and under contract up to April 1. It is a remarkable showing. They have 61 roads in operation, with 665 cars and 463.56 miles of track. They have under contract 39 roads with 431 cars and 385.20 miles of track. The total is: 100 roads, 1,096 cars, 848.76 miles of track. It is to be borne in mind of course, that this magnificent exhibition of growth in a new field is that of one company. The total of American electric roads built and under contract to-day is very closely in the neighborhood of 200.

Municipal Lighting Plants.

WE publish in this issue, from Mr. M J. Francisco, the well-known president of the Rutland, Vt., Electric Light Co., a pithy discussion of the arguments presented for municipal lighting plants, and of Mr. V. Rosewater's article in particular. It is shown by Mr. Francisco that many of the figures offered by those who would have all the lighting plants owned by the local authorities, and bought or operated out of the proceeds of taxation are erroneous. We believe with him that a large number of places could be cited proving conclusively that the statements regarding municipal lighting are incorrect and untrue.

Electrical Irrigation.

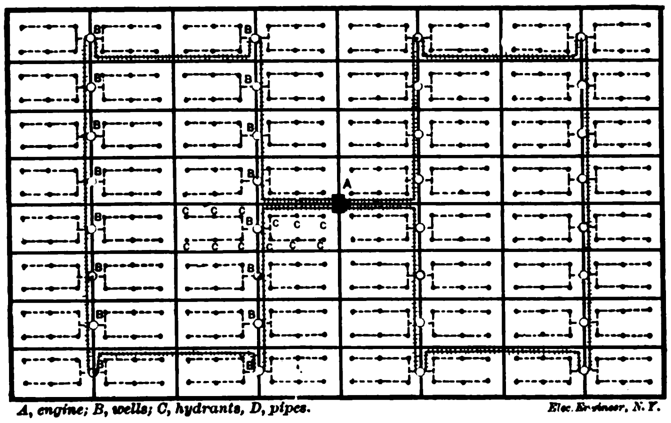
THE article which appears on the following page, from Mr. W. F. Collins, opens up an entirely new field of electrical work, and we commend it to our readers for careful perusal and criticism. There will undoubtedly be work of this kind done in the near future.

ELECTRICAL IRRIGATION.

BY W. FORMAN COLLINS.

THE importance of irrigation in dry and sterile countries and districts cannot be overestimated. Vast areas now barren and worthless can, by its means, be rendered fertile and enormously enhanced in value. One drawback heretofore in carrying out work of this class, has been the great cost of construction, operation and maintenance of suitable engineering works, and especially is this the case in regions where steam power must necessarily be employed for pumping and other purposes, and where the price of coal is high. Any method by means of which irrigation on a large scale can be cheaply effected throughout the great territories of the west will be eagerly seized upon, where its field of application and usefulness is almost unlimited.

Recent statistics show that over almost one-half of this country the rain fall is not adequate for the watering and fertilization of the crops, and the lands are of an arid character. In round numbers, 1,000,000,000 acres are of this nature, and it is estimated that there is sufficient water to irrigate 120,000,000 acres. At the present time, 6,000,000 acres are under cultivation by means of canals. These arid lands comprise the finest agricultural portion of the country, and when properly irrigated and cultivated, are infinitely more productive that those of a damp and humid character. Irrigated lands in California are bringing higher prices than the first-class agricultural districts of the east.



A, engine; B, wells; C, hydrants, D, pipes. *Elec. Engineer, N. Y.*

PLAN OF ELECTRICAL IRRIGATION PLANT.

As an example of the utilization of rivers for irrigating purposes, it has been demonstrated by survey that water from the Snake river, which is a stream of large volume and forms a boundary line between Oregon and Idaho, could be stored in suitable reservoirs, fitting sites for which are situated in Idaho and Wyoming, to an amount exceeding 2,000,000 acre-feet.

In all dry climates and semi-tropical countries, where a considerable space of time intervenes between the rainfalls, irrigation is a vital and commercial necessity, even if, in carrying it out, large expenditures are required, as the richness and abundance of the crops and the intrinsic value of the land is increased many-fold.

In devising any system of irrigation, it is of the first importance that the water supply be adequate and plentiful, not only for the watering of the land, but for the needs of the stock and other uses that it may be called upon to provide for. Irrigation may have for its object either to compensate for lack of rain-fall and thus provide sufficient moisture for the support of the crop, or for the deposition of the fertilizing agents carried by the water, in which latter case large quantities may have to be employed.

The quantity of water required for irrigating purposes, depends upon the local conditions of climate, nature of soil and product to be raised, and is subject to wide variations, in accordance with the aridness of the climate. The composition and texture of the soil has an important influence on the amount of water demanded.

It is estimated that for general agricultural purposes a rainfall of from 15 to 20 inches is about the minimum requisite when the rains are not too heavy, of considerable duration and of fairly uniform occurrence, and the temperature must also be moderate. In his report to the Kansas State Board of Agriculture Colonel W. Tweeddale, C. E., proposes to employ electricity for irrigating purposes in Western Kansas. He states that it is claimed that 336 miles of irrigating ditches have been constructed in Kansas, designed to irrigate 300,000 acres of land with water procured from the Arkansas river. The amount of water, according to the estimate of the State Engineer of Colorado, required for grain crops for this amount of land, when the rainfall was nine and one half inches during the growing season, would be 3,000 cubic feet per second; while the average discharge of the Arkansas river at Pueblo during the months of May, June and July, 1888, was but 2,000 cubic feet per second, and the ordinary flow at Hutchinson in 1876 was but 1,500 cubic feet per second, being but from 66 to 50 per cent. of the requirement. From this it will be seen that the solution of the problem of irrigation for Western Kansas must be sought elsewhere. It is the universal testimony of settlers in the aforesaid region, that the soil in the river bottom, which is, for the most part, sand and gravel, is water bearing, and that the whole of the Arkansas river valley is underlaid with a vast sheet of water which can furnish unlimited and never-failing supplies of water at depths not exceeding 25 or 30 feet. The prevalent idea is, that the source of this supply is the Arkansas river, and that the completion of the immense systems of irrigating works projected, and in course of construction in Colorado, will materially affect this supply. This alarm is causeless, and no fears need be entertained of such a result, for it is evident from various considerations that the water stored in the porous soil of the bottom lands is the source of the water supply of the Arkansas river valley, rather than the flowage of the river, which, in fact, for a portion of the year, acts as a drain to the valley, and not as a supply to the under-current.

The plan proposed by Colonel Tweeddale consists in procuring the water necessary for irrigation from the underflow of ground-water by pumping from wells and distributing by means of pipes, the power for operating being distributed by electricity. The general methods of distributing water are from open ditches, by means of rills, opened and closed with shovels or hoes.

In a general way, it may be stated that, depending on the crops being raised, the more water, the larger the yield; for which reason, to insure ample and certain supply at all time, and at minimum cost, the water should be obtained from wells. These conditions will be fulfilled by the employment of pumps obtaining their supply from a system of tube wells connected to a horizontal main constituting the suction pipe of the pump. This method allows of the construction of works for the irrigation of any desired area of land, and the larger and more complete the installation, the less the cost per acre. With two sections of land as the area to be irrigated divided into units of 20 acres each, the engine and dynamos would be located at the centre of the area, and each battery of wells at the adjoining ends of two 40-acre tracts, as shown in the accompanying diagram. The motors and pumps would be portable, and the power transmitted by means of copper wires from the dynamos to the motors. The capacity of engine, dynamo, wires, wells, motors and pumps must be such as to provide for the covering of the whole area of two sections of land with one inch of water per week, which would be sufficient for ordinary agricultural purposes.

An installation for an area of 1,280 acres would consist of a 60 h. p. engine, dynamo, poles, wires, insulators, 16 batteries of wells of fifteen points each, six motors and pumps, two extra motors and pumps being provided for the purpose of allowing for moving to new stations, and thus keeping the pumps running continuously. This outfit would be ample for irrigating, on a basis of one watering per week of one inch depth of water under a head of 30 feet.

The distribution of the water may be done as in the case of that supplied from canals and ditches ; or preferably, as the water is delivered under a head, by means of a system of pipes, hydrants, hose and monitors. The cost of distribution will vary with the character of the ground and the nature of the crop, being a minimum for meadow land having a regular delivery and a maximum in the case of fruit, when, in addition to the regular system of pipes, a line of small perforated pipes is put between the rows of trees.

This method allows of the irrigation of land situated 25 feet above the pumps, and does away entirely with all labor connected with the construction and maintenance of lateral ditches and the conducting of the water over the land by means of rills.

This scheme certainly posssses many features of interest and merit and it is noteworthy that the employment of water power to operate the dynamos, where such power could be conveniently attained even if at some distance, would materialy reduce the cost of operation, as the question is one not so much of initial cost of installation of machinery, as of continual running expenses.

In many portions of the country suitable water power, now useless, is abundant, and in the near vicinity are situated tracts of land at a higher level than the water supply, and which require nothing but irrigation to render them valuable and remunerative. To effect this by natural means is impossible on account of their configuration, and here is presented a fine opportunity for employing the power of the water fall to operate dynamos and, by transmitting the current generated thereby to motors, working pumps to raise the water of the river into suitable reservoirs and conduct it by canals and ditches or piping to the arid lands.

Further, the motors destined for pump service may be employed to operate machinery for digging the ditches and the novel suggestion has been made that in some portions of the country where gold is abundant and the soil of an auriferous nature, the dirt taken out of the ditches might be washed and made to pay the expenses of digging.

As regards the cost of electrical transmission equipment, the following figures may be taken, and although probably somewhat high, are the most nearly accurate available to the writer at the present time.

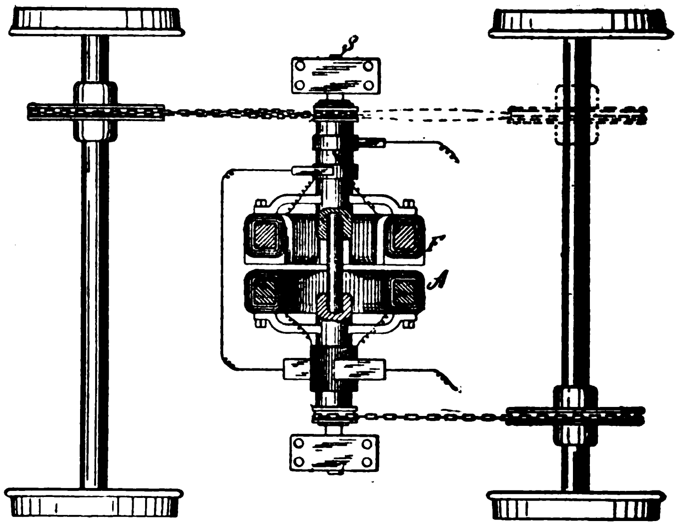
Considering a 5-mile transmission, the total cost of plant would be $160 per horse power at the motor pulley; 37,500 gallons of water per minute would be sufficient to irrigate 5,000 acres once every seven days. To raise 5,000 gallons 50 feet per minute would require 66 h. p., and figuring the efficiency of the transmission at 50 per cent., 122 h. p. would be actually needed, the cost of complete installation being about $20,000.

The many advantages of irrigation are only too apparent. In California lands now worth from $3 to $10 per acre, without opportunity or reasonable hope of irrigation, command $50 to $200 per acre when water is brought to them. The yields are far greater, the crops of finer quality and entirely independent of drouth, certain and sure, regardless of seasons, thereby benefiting the whole country and the community living on and drawing their incomes therefrom.

The application of electrical power for irrigation is as yet a virgin soil, and needs only the intellect and energy of those skilled in the art to grow and increase with rapid strides, whilst it is a field which offers almost endless possibilities for the utilization of that intangible power which is more flexible, more readily transmitted, more economical, more reliable and more easily handled and controlled than all other known sources of energy.

PERRET'S ELECTRIC RAILWAY MOTOR.

It has been pointed out on several occasions that much of the inconvenience attached to the employment of gears in electric railway work could be avoided by the employment of a motor running at a lower speed ; andthere are some who have not yet given up the hope that the sprocket and chain can be successfully applied for the transmission of power from motor to axle. Acting on this idea evidently, Mr. Frank A. Perret, of Brooklyn, N. Y., has recently brought out an arrangement which is illustrated in the accompanying engraving. The idea embodied by Mr. Perret's design is to obtain a means of independently driving the axles of the car by the use of one motor only, and secondly to reduce the difference in speed between the driving pinions of the motor and the axles of the vehicle so that less intermediate gearing will be required. At the same time it is intended to retain the moderately high speed of the armature, as related to the field magnet, which is necessary to obtain high efficiency. For this purpose it will be noted that the armature A. and field F. are independently mounted on sleeves which encircle the stationary shaft S. and the arrangement is such that both the field and the armature revolve, each in opposite directions. The power developed is transmitted to the axles by means of a sprocket and chain.



Perret's Electric Railway Motor.

The practical effect of this arrangement is that the actual speed of either motor of the system is only half what it would be were the other motor stationary, and the ratio of the gearing to the wheels is correspondingly reduced, while at the same time the relative speed between the two is the same as if one were stationary and the other revolved. It will also be noted that while one motor is employed, both axles are driven.

"INCREASED ADHESION" BY CURRENT.

BY LEO DAFT.

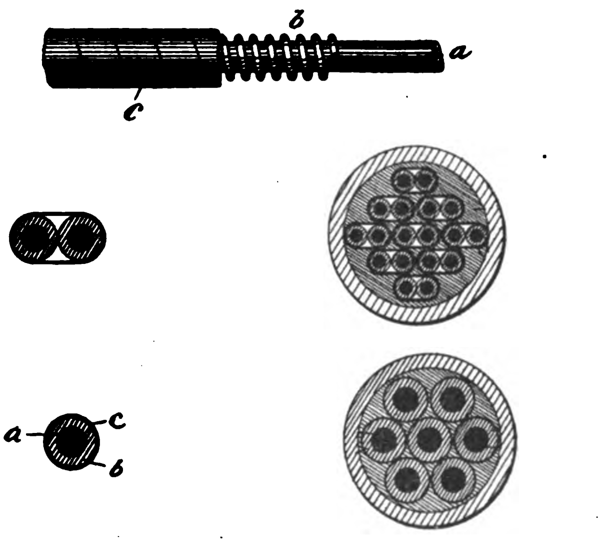
In reading the very interesting communication by Mr. Crosby in the last issue of The Electrical Engineer, I recalled many similar attempts to prove increased adhesion by current which invariably failed to demonstrate anything but the fallacy of experiments depending upon current observations in skidding an anchored car.

Not only is it almost impossible to make trustworthy readings under conditions involving such spasmodic changes, but the gradual "seating" of the wheel, due to the heating of the rail by friction at the small point of contact, frequently increases its tractive value more than I have observed with current alone.

While it must be admitted that the first experiment described in these pages in 1883[1] was unsatisfactory from a practical standpoint, the later tests made during my connection with the company bearing my name, when a small car containing one man was made to ascend a gradually increasing gradient until the possible limit due to gravity alone was enormously exceeded, seem to leave no positive doubt that with large currents the effect is a most potent factor. Subsequent experiments and a long series of observations in actual work have, however, resulted in so far modifying my views as to lead to the conclusion that with the comparatively high potentials now generally employed the currents are not large enough to produce a very marked effect, and, therefore, while I do not consider Mr. Crosby's experiments at all conclusive, he is not far wrong in his deduction.

BARRETT'S TELEGRAPH AND TELEPHONE CONDUCTOR.

Although it is well known that air presents the lowest specific inductive capacity of all dielectrics, its nature is such, of course, that except for aerial lines, it has not in the past been employed as insulating material for electric conductors. When wires are made up in the form of cables, evidently, some more substantial insulator is required, and the variety of these is very great. But the difference in the effects obtained respectively with aerial and underground lines, and noted more particularly in the telephone service, is such as to greatly impair efficiency where cables are employed, the limit of speaking distance being rapidly approached. It is with the idea of increasing the transmitting power, as it were, of a wire placed in a cable, that Mr. John A. Barrett, of Brooklyn, N. Y., has recently brought out a conductor in which, he has sought to embody, as far as possible, air as insulating material, in contra-distinction to the usual method in which the wire is entirely surrounded by some form of solid or liquid insulating material.



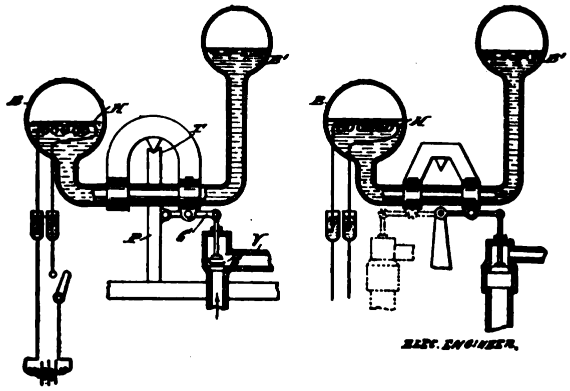
Figs. 1, 2, 3, 4 and 5—Barrett's New Conductor.

This idea has been carried out in the manner shown in the accompanying illustration, Fig. 1, in which, as will be seen, the conductor *a* is wound about with a wrapping of hard cord, which has a low, hygroscopic quality, and of the thickness suitable for the purpose required. About this wrapping of cord one or more thicknesses of paper are closely wrapped, making the whole smooth and round. After the wires have been so prepared, they are made up in cable form, as shown in two methods in Figs. 2, 3, 4 and 5.

After being properly bunched and covered with lead, the insulating material is applied, but in such a manner that it merely surrounds the paper covering of the wire, which is sufficiently dense to prevent the penetration of the insulating material to the conductor itself, and which thus always remains surrounded by a layer of air. Cables made in this fashion show a greatly reduced static capacity, and telephonic transmission through them is considerably facilitated.

THOMSON'S ELECTRIC VALVE CONTROLLER.

Our readers will recall the very ingenious form of electric meter which was brought out by Professor Elihu Thomson some time ago, in which the amount of current passing through a circuit was registered by the oscillation of a pivoted arrangement, the balance of which was disturbed successively by the displacement of a liquid caused by its vaporization, due to the heating of a conductor placed within it. It is evident that this device may be adapted for a variety of purposes, and it has more recently been carried out by Professor Thomson for the operation and controlling of valves. The accompanying illustrations show very clearly how this is accomplished. In Fig. 1, B and B^{1} are two bulbs connected by tubing and filled with an easily vaporized liquid. A conductor, such as a platinum wire, H. is placed within one of the bulbs B, and its terminals dipped into the mercury cups placed in the circuit which is controlled by a switch. It is evident, therefore, that upon closing the circuit of the coil H there will be generated in chamber B a vapor, which, as it cannot escape, will press down upon the surface of the liquid and force it towards the chamber B. This disturbes the balance of the two bulbs and the pivoted body swings over, tipping the end B^{1} down and closing the valve G. By placing the bulb B^{1} on a higher level than that of B, the emptying of the bulb B^{1} is insured when the current is taken off the coil H. Fig. 2 shows a modification of the apparatus in which the valve is opened by the tipping of the pivoted bulbs. By means of this device, evidently, a valve can be controlled at any distance by the mere touch of a push button.



Thomson's Valve Controller.

WHAT ELECTRICITY WOULD HAVE SAVED.

In a lecture on "The Electrical Transmission of Energy," recently delivered in Cambridge, Mass., Captain Eugene Griffin, U. S. A., gave statistics showing that in New England there have been only five deaths by electricity in ten years, and in the same time there have been 5,241 deaths from steam railroads. He also stated that if the West End Railway Co., of Boston, had used electricity as motive power solely last year, the company would have made a saving of $1,000,000 in money and 100 years of time to the persons using it.

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[1] See vol. II., No. 10, October, p. 301.

AN EXPOSE OF MUNICIPAL ELECTRIC LIGHTING FIGURES.

BY M. J. FRANCISCO.

AMERICA is the birth-place of the commercially successful electric light, and in five years the public demand has necessitated the investment of over two hundred millions of dollars to supply the electric lights required. From the experimental plant of 10 lights the business has increased to 275,000 arc lamps and over 3,000,000 incandescent lamps burning nightly in the United States. This large industry and vast investment has put millions of money into circulation and given employment to over 250,000 men. The benefit to many places cannot be calculated in dollars, while the additional security offered the citizens and the prevention of crime where electric lights are used is of far greater value.

Notwithstanding the benefits derived there has been engendered a spirit of opposition and a seeming attempt to assail the electric light interests of this country by false and deceptive statements as well as invidious comparisons intended to prejudice the general public. The electric light companies have been held up as monopolies, yet with all their extortion the records show that the average return or dividend received by these bloated monopolies has been only about two per cent., thus showing that they have proved of greater benefit to the public than to their stockholders.

Attempts have been made to antagonize the municipalities and the electric interests, and efforts in many cases to force the price of electric lights below the actual cost of producing them. In all these raids the fact that the companies have so largely contributed, as many of them have, to the material development, the commercial prosperity and social progress of the communities or places in which they exist is ignored.

Some party who desires a chance to dispose of a plant or secure a position raises the cry that the municipality should own and furnish the lights; the plea being that it can be done for so much less money.

Can a city secure labor or buy materials or dynamos any cheaper than a corporation, and when as shown the profits or dividends realized by the electric light companies have only averaged two per cent., how can a municipality pay four or six per cent. interest on its bonds and expect to save money by owning the plant and assuming the liabilities and losses which experience shows are sure to occur?

Hardly a week passes without some article appearing in the papers purporting to show the cost of the electric lights and the great saving to municipalities by owning the plant; the latest and one that shows an utter ignorance of the facts or experience in the business appears in the New York *Independent*.[1] This article has display head lines saying:—"Cost of Electric Lights. Boston pays $180 per lamp, and Ypsilanti only $24." By this statement the reader is led to believe that Boston is being swindled, and as a proof the cost of lights in Ypsilanti, where the city owns the plant, is given as a comparison.

What are the facts? Boston is furnished with lights all night and every night in the year, and the company producing the same have to use steam power with coal $4 or $5 per ton, besides having to pay the city heavy taxes.

Ypsilanti uses water power costing nothing; burns the lights only 20 nights each month until midnight, and uses the buildings belonging to the water-works of the city, and salaries and expenses of men to run the lights are charged to the water department.

In the same article, Topeka, Kan., is cited as the Mecca where lights only cost the city $72 per year for all night.

Topeka purchased an electric light plant of 184 lights for $50,000 and the company or parties who sold the plant to the city, represented that the cost of each lamp would be $6 per month or $72 per year. This amount is given in the article referred to as the cost of lights in Topeka. The city officials have found by actual experience, and so report, that the cost of running the lights is $11 per month or $132 per year for each lamp. The mayor states it as his opinion that it would have been much cheaper in the end for the city to have contracted with the local electric light company for the lights.

Dunkirk, N. Y., is quoted as burning 55 arc lights all night every night, at a cost of only $36.50 per year; about $3 per month. The cost for the month of October as reported was $225.28, not including superintendent, engineers' and firemen's salaries, interest on plant, depreciation and repairs, as these are paid by the water department. Add to this the salaries of superintendent, engineer, fireman, interest, depreciation, repairs and taxes, which an electric light company would have to pay and which the city does pay, but charges to another department, and the cost is $625 per month for 55 lamps, or over $11 per month per lamp and $132 per year.

Chicago is cited as a sample of municipal lighting, and where it only costs the city $65.60 per year. But J. B. Barrett, the superintendent, writes that this price does not include any expenses, such as taxes, water rents, interest on investment, insurance, repairs or renewals in general.

Any electric light company would be glad to furnish lights at the price claimed it costs Chicago, if all their expenses, repairs and such disbursements as are specified were paid by some other corporation.

The *Independent* writer, Mr. V. Rosewater, gives $105.13 as the average price paid per year by cities, to private parties, for lights. This is $26.87 less than it costs the City of Topeka to furnish their own lights.

These are samples of the comparisons that are being made by the advocates of municipal lighting, and it is surprising that a man who claims to be connected with Johns Hopkins University should be willing to attach his name to a communication containing so many statements that are manifestly incorrect, misleading and unjust to the electric lighting interests of the country.

In connection with municipal lighting, why did not Mr. Rosewater refer to the largest municipal lighting plant in this country and the operations of the great gas trust of Philadelphia, where the city lost $3,500,000 in six years in owning and operating its own lights; and notwithstanding the city now owns the gas plant, they are contracting with electric light companies to light their streets and paying according to the *Independent* statement, $177 per year, for each lamp. Here is a city that has tried municipal lighting for years and abandoned it, and hires local electric light companies to furnish the lights, and pays more than three times as much according to this writer as it costs other cities to produce them.

Which is the best authority, actual experience, or the theory of parties with no practical knowledge of the business?

AN ELECTRIC INSECT TRAP.

It is told of Mr. Edison that in his early days, when his thoughts had not yet been directed towards the fields which have since proved so prolific of results, his inventive genius, ever restless from the beginning, was called into play to devise a method for removing some troublesome insects which had for a long time infested the telegraph operating room in which his desk was situated. For this purpose two strips of metal were placed along the wall about one-eighth of an inch apart and insulated from each other, but connected to the opposite poles of the main line battery. By the application of a suitable bait the insects were induced to cross the gap between the two parallel strips, and it is needless to say that the instant they made contact between the strips they dropped lifeless to the floor. We are reminded of this by the issuance of a recent U. S. patent to Mr. François Scherer, of Paris, France, in which the inventor seeks the destruction of the unwary insect by placing within a cage-like structure an electric lamp and surrounding it with a gauze-like frame, the alternate bars of which are connected respectively to the opposite poles of an electric battery. It presents the somewhat anomalous feature that the insect to be destroyed meets with its fate on the outside of the trap instead of the inside, as is usually the case.

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[1] The ELECTRICAL ENGINEER, April 9, p. 214.

SWINBURNE'S ALTERNATING CURRENT MOTOR.

Among those who have given considerable attention to the design of alternating current apparatus during the past few years is Mr. James Swinburne, of London, whose theory in regard to the construction of transformers is embodied in the "hedge-hog" type of transformer with open magnetic circuit. Recently Mr. Swinburne has devoted his attention to the development of alternating current motors and as a result there has been lately issued to him in England a patent for a new type of alternating motor.

This machine is designed so that at any instant its back electromotive force is just less than the electromotive force on its terminals by enough to cause the armature current needed to give the power. At no load such a motor should give a back electromotive force which at any instant is almost exactly equal to the terminal electromotive force. At full load the field is weakened enough to let the necessary current pass, so that the motor does not need to lag much and weaken its field by the reaction of its armature current.

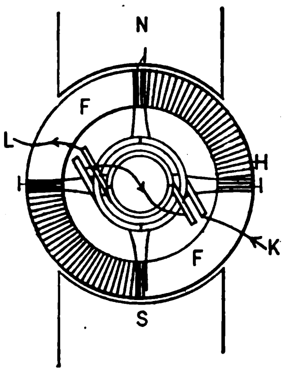


Fig. 1.

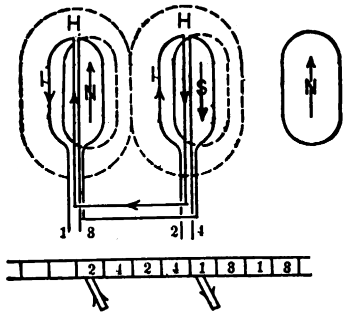


Fig. 3.

Various ways of exciting this machine, both separately and by self-excitation are employed by Mr. Swinburne. In one form the exciting circuits are so arranged that at no load the field excitation gives a back electromotive force approximately equal to the electromotive force in the mains. If it has very nearly the same back electromotive force, the motor at no load becomes co-phasedly synchronized and takes just enough current to drive it and give power for excitation. It is found best, however, to allow a margin so that the back electromotive force is a little less than the main electromotive force. The motor then leads a little at no load. This slight lead allows a small armature current to pass which strengthens the field by reaction. This increases the excitation, as the exciting coils in the armature come under the influence of the same pole pieces. This again increases the back electromotive force, so that neither the lead nor the armature current becomes excessive. If too much margin is allowed, the motor will lead too much, and will take a large current at no load, which is wasteful.

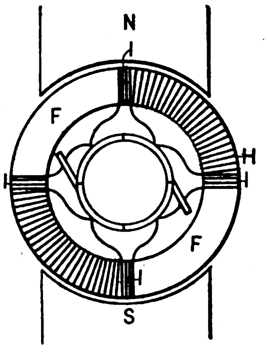


Fig. 2.

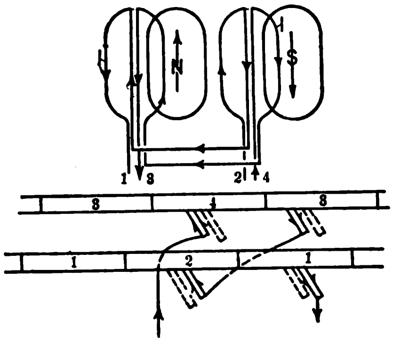


Fig. 4

When load is put on, the motor begins to lag. The armature current then reacts on the fields and weakens them; this weakens the field excitation, as the exciting coils are influenced by the same field magnets, and the field can thus be weakened enough without much lag. The field excitation is so designed that the iron is not highly magnetized. On the other hand it must not be too sensitive.

The inventor has carried out his ideas in a variety of forms. One of these is illustrated diagrammatically in

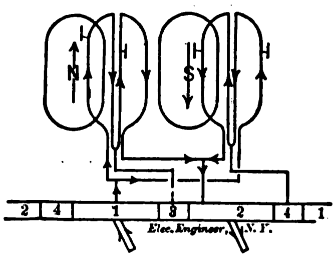


Fig 5.

Figs. 1 and 2, in which a ring armature F is employed, a two-pole machine being shown for the sake of simplicity. H H are the active or main coils of the machine, which are connected to the connecting rings as usual, and I I are the exciting coils of the armature. The brushes are in connection with the field magnets by the leads K L. If the armature is stationary and the field rotates, the brushes are connected to the armature coils, and the sections of the commutator to the field circuit. In Fig. 2, the exciting coils are connected up as in the Gramme ring. This arrangement demands four brushes and two sections when the armature is stationary and the field rotates.

Fig. 3 is a diagram of the exciting armature coils in a machine whose armature is made of a flat strip without an iron core. The main coils H H and pole pieces N S N are shown with parallel sides, instead of radial, for the sake of simplicity. The main armature coils are shown as dotted flat oval coils H H. They are connected to collecting rings in the usual way. Inside the main coils, in the space at present generally left vacant, are pairs of exciting coils shown as full lines I I. These coils are more clearly distinguished in Figs. 4 and 5 where the main coils H H are omitted. N S N are diagrammatic representations of the pole pieces in the figures. The arrows on the pole pieces show the direction they induce a current when a conductor passes from right to left. The arrows in the coil circuits show the direction of the induced exciting currents. In Fig. 3 two pair of coils are shown. Each pair is connected in series. 1, 2, are the ends of one pair, and 3, 4 the ends of the other pair. In an actual machine instead of two

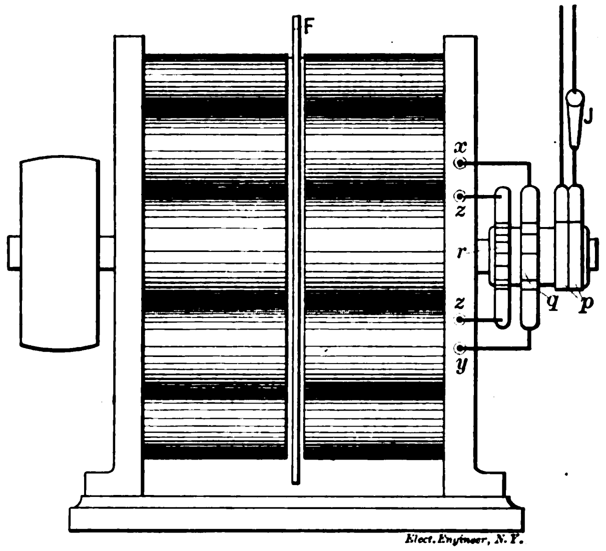


Fig. 6.

pairs there are two sets of correspondingly situated coils, coupled, in series.

Below the diagrams of the coils in Figs. 3, 4 and 5, are diagrams of the commutator sections, and the brushes, which are connected with the field magnet circuit. The numbers on the commutator sections show which ends of the coils I I are connected to them. In Fig. 3 each set of active coils is in circuit when it has an electromotive force induced in it, the other set being out of circuit. Fig. 4 is analogous, roughly, to Fig. 1. There are two commutators and two pairs of brushes, and the sets of coils are in series. For starting the motor the brushes are shifted to the dotted positions, and the main current is passed through both the field and armature circuit; and when speed is attained, the connections are altered. Fig. 5 shows an arrangement somewhat analogous to that of Fig. 2.

The machine, which is designed both as a motor and a generator is shown complete in Fig. 6. Here p represents the collector for the main armature current, and q is the commutator in series with the armature current, for weakening the field in case of a motor, and strengthening it in the case of generator.

Here also, x y are the terminals of the main or series field coils, and r is the commutator in connection with the armature exciting coils, for exciting the field magnets; z z represent the terminals of the field circuit connected to it. To start the machine as a motor the brushes of the series circuit are shifted so that the series wire magnetizes instead of demagnetizing. The main current is then turned on through a safety resistance. When the machine has reached its normal speed the brushes are shifted to their proper position, and the load is put on.

A "ROSEWATER" VIEW OF MUNICIPAL LIGHTING.

BY ALLEN R. FOOTE.

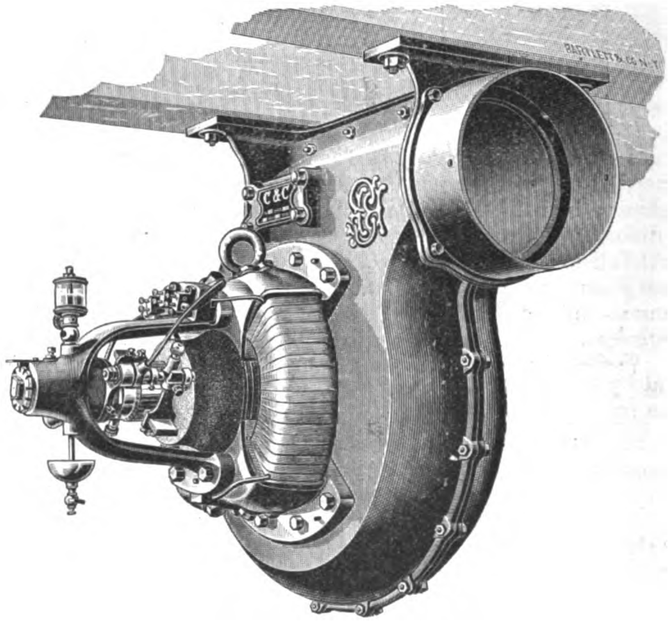
THE people of the United States for the past few weeks have witnessed a stupendous exhibition of unutilized genius. An article has been furnished for publication, originally to the *Independent*, that has appeared as a reprint in a number of journals, purporting to give the cost of lighting in a large number of cities. The intention of the article is to show how much more capable politicians are, as managers of an electric general station, than those men who have their capital, livelihood and reputations at risk in the management of such undertakings. It is no wonder that such a discovery should attract universal attention.

In this article, the cost price given for all-night lighting in nine cities owning the plants, averages $53.80 per lamp per year. It is ordinarily estimated that one arc light requiring about forty-five volts and nine amperes, consumes one horse power of steam at the engine. In an article appearing in the *Buffalo Express*, April 3, it is stated that a horse power of steam costs $39 per year in Rochester, N. Y., $46 in Lockport, N. Y., and $45 in Baltimore, Md., making an average of $43.33 per year. At this cost for steam power the difference is $10.47, to cover all other expenses of operating the electric light plants in the nine cities named. The carbons will cost $5.40 per lamp per year. This will leave those cities but $5.07 per lamp per year for all other expenses, including depreciation and the interest on the investment.

I believe that the central station companies of the United States can make no better investment of money than to employ these "literary fellers" to teach them how to run their business. They must have some secret not possessed by those practically engaged in the work. For no man in the actual management of a plant has been able to keep his expenses within their limits. I suggest that the National Electric Light Association employ Mr. Rosewater to instruct its members how to operate arc lights at a cost of $53.80 per lamp per year. If he will guarantee to do this, I think that every company in the country would take a membership in the Association to get the benefit of the instruction. By dividing the "gate money" with him, Mr. Rosewater would have an income of about $10,000 per year from the operation. With that amount I am sure he could buy a lease of absence from Johns Hopkins University, and have a good wide margin for profit left. This profit, I presume, he would at once cover into the treasury of some charitable institution, as he preaches the gospel of "no profit for lighting plants." He certainly cannot object to the expectation that Rosewater would not retain a profit for operating the "Rosewater" lighting plant for the illumination of the National Electric Light Association.

VENTILATION ON BOARD SHIP.

THE ventilation of ships has in the last few years received considerable attention, and especially since the introduction of electric lighting on ships has placed at the disposal of the engineer a ready means of solving what has heretofore been a practically unsolved problem, so far as general ventilation of a ship was concerned. With the dynamo current available, its application to the driving of electric motors attached to fans and blowers was a natural step. The electric blower can be put anywhere, as the wire carrying to it the current which furnishes the motive power, can be introduced into one place as easily as into another, and this application of the electric current provides at once a most convenient and in some cases the only means of thoroughly renovating and purifying the air.



ELECTRIC BLOWER ON U. S. MEN-OF-WAR.

The orifice of discharge in a blower is smaller in proportion to the amount of air passing through than that of any other machine for creating a forced draught of air, and this especially recommends it for ships and in places where the discharge current of air has to be carried a distance in pipes, as the pipes required are small and no special provision need be made beforehand to allow space for them. Any blower such as would be ordinarily required for this purpose must be small and not obtrusive to the eye; and hung on the ceiling, it is out of the way. By a small pipe the discharged air can be carried to the deck or any convenient point without taking room that might be needed for other purposes.

As an example of this new and important class of work we illustrate a blower directly connected to a C. & C. electric motor. This blower has been placed by Messrs. Cramp & Sons' Ship and Engine Building Co. on the U. S. cruiser "Baltimore." It is type No. 4 and discharges 1,425 cubic feet of air per minute. Fastened to the ceiling of the dynamo room it completely changes the air of the room once every two minutes, discharging it at a distant point through a small pipe. The entire machine is so compact that it takes up no space that could be used for anything else and does its work so noiselessly that a person standing near cannot tell without the closest observation whether it is running or not.

The ease with which these blowers can be set up and connected to the dynamos, without requiring any shafting, belting or other contrivance except the small wire, has already brought them to the attention of ship builders, and both the cruisers "Charleston" and "San Francisco" launched on the California coast recently, as well as the "Philadelphia" from Cramp's Yards, have had blowers placed in their engine rooms.

WIGHTMAN'S CONTROLLER FOR RAILWAY MOTORS.

It is well known that in starting a series wound electric motor some means must be provided to prevent an abnormal rush of current through the armature, as, being stationary, it can afford by itself no opposition or counter electromotive force. There is thus required either the placing of a resistance in circuit for starting, or an arrangement for creating sufficient self-induction in the armature to prevent excessive current. On the other hand, when the current through the motor is ruptured suddenly, the self-induction which takes place is manifested by an energetic flash at the point of rupture. In the case of the electric motor the field magnets are specially liable to have their insulation punctured by the high potential generated by the self-induction. This "kick" of the field magnets, as it is sometimes called, has been sought to be overcome by placing immediately upon the core of the magnet a copper sheath in the shape of a spool upon which the insulated wire of the winding is coiled. This sheath constitutes a short-circuited conductor about the magnet, and its action is to retard, or slow down, the rate at which the field can lose its magnetism, and hence is able largely to prevent the sudden rise of potential formerly experienced.

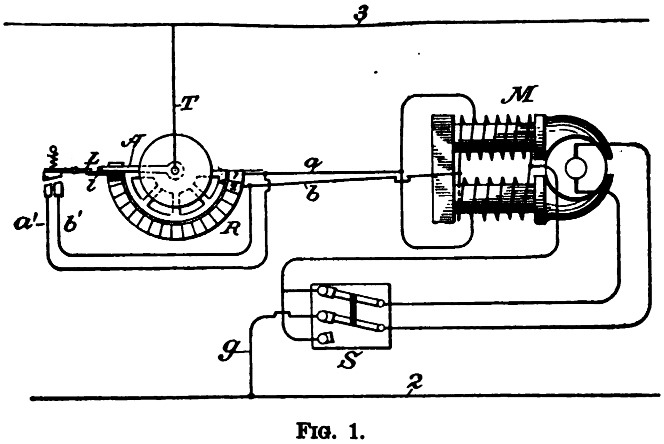
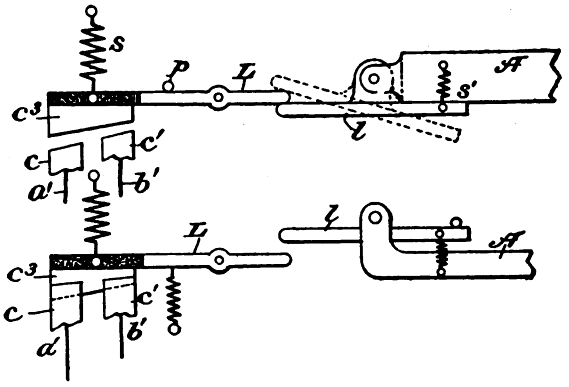


FIG. 1.

But the presence of this short-circuited conductor when the current is first turned on the motor will be detrimental because it is then desirable that the field magnet should oppose a strong counter electromotive force, and hence in this case the sheath is rather a detriment than an aid.

In order to retain the advantages of the close-circuited conductor, but at the same time to avoid the inconvenience just pointed out, Mr. Merle J. Wightman has designed a method by which the short-circuited conductor may be opened or closed so that the operator on an electric car, for instance, can have the short circuit closed at the time the circuit is broken, and open when he wishes to start the car. For this purpose Mr. Wightman employs what is known as a biased switch; that is, one in which a spring or weight normally tends to hold in one of two positions. The manner in which this is carried out is shown in the diagram, Fig. 1, which illustrates the motor and circuits; Fig. 2 showing an enlarged view of the open circuiting switch.



FIGS. 2 AND 3.

As will be seen, the section of the field magnet coil included between wires *a b* is used as the short-circuited conductor on the field, which takes up the extra current ensuing on breaking the circuit. The short circuit for this section is completed by a circuit-breaker and closer. *c c'* are two contacts of this device joined to wires *a b*, while c^3 is the circuit-closing plate that, by making contact with both plates *c c'*, closes the short circuit. The circuit closer is held open normally by a spring *s* against a stop *p*.

The lever L of the circuit-closer and breaker is engaged by a trip-lever *l*, pivoted on the arm A and provided with a spring *s'*, that normally holds it in the position shown in full lines in Fig. 2. These parts are so arranged that at the instant before the main switch opens the circuit the trip-lever *l* with the circuit-closing lever L, and will close the short circuit and keep the same closed until the main switch has moved sufficiently far to put out any arc that might follow on rupture of the circuit. After this point is passed the trip-lever *l* escapes by the circuit-closing lever, so that on return of the lever A for the purpose of again closing the circuit the trip-lever *l* slips by the lever L, in the manner indicated by the dotted lines, Fig. 2.

The circuit through the motor is from conductor T through switch A, rheostat R, line *b*, fields of motor in multiple, reversing switch S, armature of the motor, back to reversing switch S, and out at *g*.

The operation of the apparatus is as follows: Normally the section of winding connected to *a b* performs its ordinary function of energizing the field magnet, its short circuit at the switch *c c'* being open. If the main switch A be turned to open the circuit of the motor the section of field winding will be short-circuited at the instant of rupture of the connection through the motor. The strong induced currents circulating in this winding will have the effect of retarding or cutting down the heavy extra current and preventing destructive sparking or generation of dangerous potential in the field windings. After this operation the circuit-closing device opens the short circuit for the section of field-coil, and maintains the same open until a repetition of the operation just described. As the switch is turned back to close the circuit through the motor, the short-circuit-closer for the section of field-winding maintains its open position, as just explained; hence the field-magnet coils may exercise freely the self-induction, which will prevent a sudden rush of current through the motor and consequent injury at the time of starting the motor. As the arm A is turned, the resistance is gradually decreased and the motor speed gradually increased, until, finally, the switch passes to the contact *l*, thereby cutting out a section of the field-winding and still further increasing the speed beyond the capacity of the rheostat to do so by diminution of rheostatic resistance.

In the engraving, Fig. 3, another form of this switch is illustrated, in which the arrangement above described is reversed, the arrangement being such that the switch normally keeps the short circuit closed, instead of open.

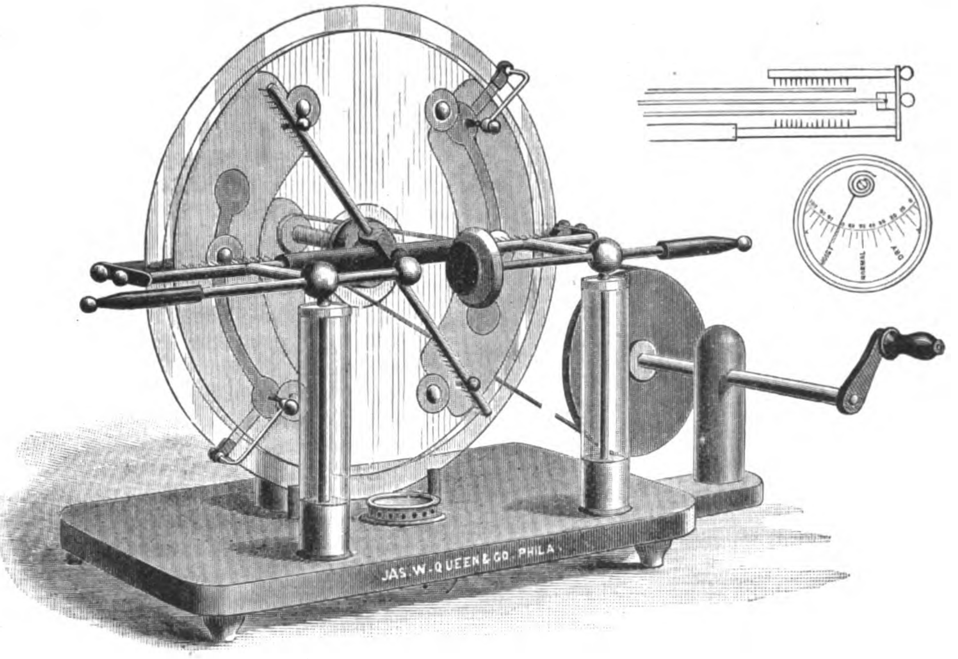
A NEW TRIPLE-PLATE TOEPLER-HOLTZ MACHINE.

Probably the machine most generally employed in the study of static electricity at the present time is the Holtz or some of its modifications, and among these the Toepler-Holtz machine has risen to considerable prominence. The latter machine was introduced into the United States in the year 1880 by the late Joseph J. Walton, of Messrs. Queen & Co., of Philadelphia, and has since then been variously modified from its original design. Still further improvements have recently been made which have resulted in a practically new type of machine.

The new machine which is illustrated in the accompanying engraving, as its name indicates, is a three-plate machine; it is not, however, the same thing as the machine usually spoken of as the "double revolving plate machine," although it does have two revolving plates. The latter machine is simply an ordinary Toepler-Holtz machine doubled; *i. e.*, with a revolving plate behind the fixed plate, exactly like the one in front, and acting in exactly the same manner.

In the new form, the additional plate is not like the front revolving plate, nor does it act in at all the same way. The third and additional plate is here a perfectly plain glass plate, mounted upon the same axis as the usual revolving plate, and placed behind the fixed plate. Its *modus operandi* is, like many other points in the theory of the Holtz machine, not entirely understood, although there is no doubt that much of the increased efficiency obtained by its use is due to the screening effects it has upon the other plates, that is, to the leakage that is prevented by its presence. There is also supposed to be a considerable generation of electricity by friction of the plain plate and the air. Undoubtedly many other causes also tend to increased effects of possibly even greater importance than those just mentioned.

Another improvement that is made in this machine is the form of the electrode which is used. This is made of a metallic disk two inches, or more, in diameter and hollow, so as to have very gradually rounded edges, thus preventing any leakage at the edges. Over this disk, separated from it by about an eighth of an inch, and nearer the other electrode, is fastened a thin disk of vulcanized rubber, about half an inch less in diameter. This rubber disk plays the part of the rubber sheet sometimes held between the electrodes before a spark can pass. It can be used upon either one or both electrodes.



A New Triple-Plate Toepler-Holtz Machine.

The advantage of this new form of machine becomes especially marked during moist weather. At such times ordinary frictional machines will not work at all, and hence all older text-books direct that electrical experiments must be performed during January and February, when the weather is clear and dry. With the Toepler-Holtz machine, as now known, this requirement has not been so rigid, although such machines are not always to be trusted during damp seasons, as lecturers have found out to their sorrow.

In testing two of these machines last September, Professor Wm. A. Anthony, in order to determine whether the extra plate gave any increased effect to the machine, set up both machines and arranged them so that they both could be revolved by means of one crank, and so that they both ran at the same speed, and then adjusted the terminals until the sparks occurred with about the same frequency in both. He then removed the combs from one of them so that the third plate would have no effect in the development of electricity, and found that the frequency of sparks on that machine was very much less than on the other. He repeated this several times with the same result, and tried the same experiment on the other machine; that is, leaving the combs on the first machine, he removed them from the second, when that one was found to give considerably less electricity than the first. From this it was evident that the addition of the third plate very much increases the rate of discharge, and, as nearly as could be determined by this rough experiment, about double, the rate.

Professor Anthony also found the machine to work uniformly well in all weathers. As our illustration shows, the machine is provided with a hygometric gauge, which indicates the amount of moisture in the atmosphere. These machines, we may add, are now being made in various sizes by Messrs. Queen & Co.

TESTU TELEPHONE.

This instrument, says the *Bulletin Internationale*, looks almost like a watch, and is chiefly interesting because it has been adopted on the government telephone service. In the interior of the case, and screwed to the under side, are two concentric bowls of soft iron, superposed and each with a large edge carrying six sloping pieces disposed symmetrically. They are each furnished with a winding giving a reverse polarity, the outer bowl being a south pole and the inner a north pole. The two coils are connected in series, and have a resistance of about 55 ohms. The vibrating membrane is placed above the two electromagnets and forms the upper lid of the box. The inventor of this apparatus, M. Testu, is special agent of the Administration of Posts and Telegraphs.

ELECTRIC TRAMWAY DATA.

BY CARY T. HUTCHINSON, PH. D.

In this paper I purpose giving a short account of measurements made by me for the Sprague company, and published with their consent, on several electric tramways; the measurements are chiefly electrical, but in some few cases engine tests were made. The data refers entirely to Sprague roads.

The same instruments were taken from place to place; they were two Weston voltmeters reading to 600 volts; two Weston ammeters reading to 100 amperes; a Wheatstone bridge set with 20 cells of battery; Tabor indicator, tachometer, speed indicator, etc. The electrical instruments had been calibrated just before starting out. I expected to have an ammeter reading to 300 at least, but it was not ready in time; hence for station readings the station ammeters had to be used.

All the roads are of the overhead, underrunning trolley system, with main conductors parallel to trolley wire along the sidewalk, connection being made at short intervals; the roads will be referred to as "A." "B," "C." "D" and "E."

A brief description of the character of the roads will be useful. Road A is divided into two parts by an "incline plane," about 1,000 feet long, having an inclination of about 35 per cent.; this incline is operated by a cable. The cars run through the lower part of the city, the business part, to the incline; here they are lifted by a carriage on the incline to the top of the hills and continue on out into the residence portion of the city.

When these tests were made the incline was not working, owing to an accident some weeks before; hence the road was running in two separate sections, the lower and the upper. The lower end has about 1.03 mile, and the upper 1.92 mile of double track. The rails are used here as return, there being no copper wire parallel with the track. This road is very uneven; there are very few level parts, and one grade as high as 15 per cent. for a short distance, and with almost all grades up to this.

POWER HOUSE:—

The power house is at the head of the incline, nearly at the middle point of the line.

It contains:—

Two tubular boilers 16" x 66" with 54 flues; heating surface, 1,089 square feet; grate surface, 22.7 square feet. These are rated at 90 h. p. at 90 lbs. pressure. They supply steam to the engine used for the cable as well as for the dynamo engines.

Two engines, the first a Ball 16' x 16", running at 240 revolutions, of 150 h. p.; the second a Greenwald (Brown) 18" x 42", running at 70 revolutions, of 150 h. p. Each of these engines drive two 50-kilowatt Edison shunt dynamos, 500 volts, at 845 revolutions. The slow-speed engine is belted to a countershaft; the high-speed directly to the dynamos. The Ball engine is held only as a reserve.

Usually 20 cars are run, some with tow cars; but at this time only ten were in use on account of the accident to the incline. The station is operated about 19 hours per day; the car mileage is 107 per day, and the duty of cars about 230 car hours per day.

Here, the engines were indicated, and coal weighed, first using the Ball and then the Greenwald engine, reading of currents and E. M. F. being taken at the same time for a run of 8½ hours; the time was chosen so as to give as nearly as could be judged an average result; this is, the loads carried would average for the time about the same as if the tests had been taken for the entire day's run. Car readings and grade readings also were taken.

December 20. Greenwald Engine.

Readings taken from 9.30 A. M. to 6 P. M.=8.5 hours. Current and E. M. F. readings every minute. Engine cards every half hour.

Average (for time) number of cars	8.26
Mean E. H. P. from station readings	54.6
Mean E. H. P. from station readings, per car	6.6
Mean I. H. P.	67.2
Mean I. H. P., per car	8.1
Coal burned	2,283 lbs.
Coal burned per I. H. P., per hour	3.96 lbs.

December 22. Same arrangements, except Ball engine.

Readings from 9.25 A. M. to 6 P. M.—8,6 hours.

Same number cars	8.26
Mean E. H. P. in station	56.2
Mean E. H. P. in station, per car	6.8
Mean I. H. P.	66.3
Mean I. H. P., per car	8.0
Coal burned	3,835 lbs.
Coal burned per I. H. P., per hour	4.98 lbs.

The average number of passengers per trip was not more than six to seven.

The friction card taken from the Ball engine turning both dynamos with the field circuits closed was 21.5 h. p.

READINGS ON GRADES:—

No. 1. Mean grade 6 per cent., 965 feet long, with maximum of 10 per cent. for 80 feet and 15 per cent. for 90 feet.

Speed, 5 miles per hour; 10 passengers.

Power required	21.2 h. p.

No. 2. Same repeated.

Power	23. h. p.

No. 3. Straight 4 per cent. grade for 2,472 feet, perfectly regular.

Power	18 h. p.

Insulation resistance 25,000 ohms for the entire system, about six miles of pole; this is .15 megohm-miles.

COST:—

I am not at liberty to give the actual cost of operation for many reasons, but shall give here certain ratios which may be instructive.

By "cost per car-mile" I mean the cost of "generating the power," plus cost of keeping cars and line in repairs, *i. e.*, maintenance, plus cost of motormen and conductors, reduced to a car-mile basis. This excludes office expenses, rent, interest, depreciation other than repairs, salaries of clerical force, insurance, and, in fact, all general expenses of this nature. Cost of "generating power" or "central station" includes fuel, oil, waste, water, and attendance, *i. e.*, engineers, oilers, firemen, and all force about station.

Central Station Cost, Maintenance, Carmen = "Cost" per Car-Mile. The carmen form the very large part of this difference; other things are practically very small. Sometimes an employee, as an "electrician," works on the line and motors, as well as in the power house, so that, strictly, his time should be charged partly to one account and partly to another. This is not practicable, and so such a one is charged entirely to the power house.

Maintenance includes the entire cost of keeping cars and line in repair, *i. e.*, materials and wages.

On road "A.," then, putting the cost per car-mile at 100, the distribution is as follows:

Carmen	71.5
Maintenance	1.8
Generating power	26.7
	100.

Further the power house item is divided into

Labor	20.
Fuel	5.9
Oil, water and waste	.8
Generating power, total	26.7

ROAD "B."

This road is almost pefectly level; no grades worthy of the name exist. It is divided into two branches, which keep together for about 2.5 miles and then diverge. On one route there is about 5.5 miles and on the other about 4.94 of double track.

POWER HOUSE:—

The power house is placed at almost the middle point of the line; the equipment consists of the following:

Boilers.—Seven tubular boilers, 18″ x 6″, 70 flues; heating surface, 1,488 square feet; grate surface, 33 square feet, rated 150 h. p.; 90 lbs. pressure. These boilers all have Murphy mechanical stokers.

Engines.—Three Armington & Sims, 18⅛″ x 18″, 200 revolutions; 250 h. p.; three A. & S., 14½″ x 15″, 260 revolutions; 125 h. p. Each engine is belted directly to two dynamos.

Dynamos.—Six 80-kilowatt, compound wound, with carbon brushes, two to each large engine. Six 40-kilowatt, shunt; two to each 125 h. p. engine. These last are to be compounded.

The station runs 24 hours per day. From 1 to 6 A. M.; only two cars are on the line; the rest of the time the average is about 30. Motor cars draw tow cars about two-thirds of the time; for example, during November, car No. 142 ran 3,098 miles, of which 2,247 miles was with a tow car; this was about the average. From this a car runs 103 miles a day; train, 75 miles per day. Speed from 6 to 9 miles per hour; average about 8.

CAR READINGS:—

No. 1. Motor car with tow, 16-foot cars. Round trip about 11 miles; 40 passengers; 30 per cent. of readings were zero, *i. e.*, current off; speed 7.2 miles per hour; mean starting current, 95 amperes; maximum starting current, 120 amperes.

Power on car.............................. 8.5 H. P.

No. 2. Same motor car but no tow; round trip 11.7 miles; speed 7.6 per hour; 18 passengers; 40 stops; 33 per cent. of readings, zero; mean starting current, 80 amperes; maximum, 100 amperes.

Power on car.............................. 6.17 H. P.

From tests made by the company's engineers, engine cards and electrical readings being taken every half hour, they find:

Mean average, E. H. P	276
Mean average, I. H. P	360
Ratio, $\frac{\text{E. H. P}}{\text{I. H. P}}$	77 per cent.

The number of cars running at the different hours of the day was not noted by them.

The insulation resistance was 6.9 megohm-miles for about 15 miles of poles; separate feeder circuits gave 2.9, 1.4 and 10 megohm-miles; the low figure was for a line running through trees.

COST:—

Since motor power cars tow a large part of the time, there can be no reduction to a motor car mile, or to a train mile simply; but,

Average number of motor cars per day	23.4
Train mileage	75
Motor car mileage	103

The motors tow for 73 per cent. of the entire time; this is:

23.4 x .73, average number of trains	17.1
23.4 x .27, average number of motors alone	6.3

Further, if X be the total cost per train mile, and Y be the total cost per motor car-mile (without tow), then, $\frac{17.1\,X + 6.3\,Y}{23.4}$ is the cost per car-mile run by the motor, regardless of towing.

This figure will be meant when "cost per car-mile" simply is used, and is to be distinguished from "cost per train-mile" and "cost per motor car-mile."

If the "cost per car-mile" be 100, then the distribution is as follows:

Carmen	73.7
Maintenance	14.
Generating power	12.3
Total	100.

And of the cost of the power house:

Labor	6.4
Fuel	4.2
Oil, waste, water, etc	1.7
Generating power, total	12.3

RATIO OF COST ON TRAIN TO COST ON MOTOR CAR:—

The cost of conductors and motormen is in the ratio, $\frac{\text{Train}}{\text{Motor car}} = 1.47$; this item is 73.7 per cent. of the total.

The power required for a train is, say, 1.4 times that for the motor car; but attendance at the power house is not increased, and oil is increased inappreciably; about the only increase is in fuel, and fuel constitutes about ⅓ of the power house expense.

Therefore, the ratio of the cost of power, $\frac{\text{Train}}{\text{Motor}} = (\frac{2}{3} + \frac{1}{3} \times 1.4) = 1.13$. This item is 12.3 per cent. of the total. Repairs are alike for both, and are 14 per cent. of the total. We have then:

$$\text{Ratio of total cost, } \frac{\text{Train}}{\text{Motor Car}} = .74 \times 1.47 + 1.13 \times .12 + .14.$$

$$\text{That is, } \frac{X}{Y} = 1.37.$$

ROAD "C."

The road here is entirely single track with turnouts about 4 miles long; there are many grades, some of 7 or 8 per cent; in fact, the entire road is up and down-hill. The road is in the form of an L, with the power house at the junction; one branch has a return copper conductor; the other uses the rails connected at intervals to buried earth plates for the return.

POWER HOUSE:—

Boilers.—Two tubular 18′ x 6′; 68 4″ tubes. Heating surface, 1,450 square feet; grate surface, 33 square feet; rated at 150 h. p.

Engines.—Three Ball 16″ x 16″, 240 revolutions, 150 h. p., belted directly to dynamos.

Dynamos.—Six 50-kilowatt Edison; four are shunt, but are soon to be compounded.

Nine or ten cars run constantly, and both boilers are used with two engines and four dynamos. They burn about 6.7 tons of coal per day of 16 hours. Round trip about 8 miles. Car mileage 105 per day.

Car Readings.—Readings every 30 seconds; number of passengers, 18; number of stops, 30; mean starting current, 47 amperes; power, 7.74 h p.

POWER ON GRADES:—

1.38 per cent.	—650 feet	10 H. P.	Ave. 11.9
1.4 "	—900 "	12.4	
1.5 "	—1,600 "	13.4	
3.25 "	—800 "	15.	
3.8 "	—800 "	17.3	Ave. 18.5
3.8 "	—1,200 "	19.8	

The load in all cases was about 9,000 to 10,000 lbs., and the speed from 7 miles per hour to 5 on grades.

The insulation resistance was 3.2 megohm-miles, with about 8 miles of poles. The resistance of the copper overhead conductor and return underground by copper wire and rails of the section fitted this way is 2.25 ohms.

Calculated resistance of outgoing circuit.	1.38 ohms.
Return	.87 "

The distance was two miles. This was the only place at which I succeeded in making this measurement; there was always some interference by extraneous currents, giving large deflection when battery circuit was open.

I have not been able to get the cost of operating this line.

ROAD "D."

The town here is entirely flat; there is a main line with six branches tapping the main line at various points of its length and running to both sides of it. The power house is at one end of the line.

POWER HOUSE:—

Boilers.—Two tubular 78″ x 16′; 104,2″ tubes. Heating surface, 1,013 square feet. Grate surface, 33 square feet.

Engines.—Two Ball, 16″ x 16″; 250 revolutions; 150 h. p.

Dynamos.—Four 50-kilowatt Edison shunt wound.

About 17 cars are equipped and 14 of them run for 18 hours; one engine and one pair of dynamos are used from 6 A. M to 3 P. M., the other set from 3 P. M. to 12 midnight.

The speed was about 6 miles per hour; there was no towing; the car-mileage is 105 per day.

Car Readings.—Readings every 30 seconds; 8 passengers, 30 stops; mean starting current, 75 amperes; power, 8.62 h. p.

GRADE READINGS :—

Flying start, 9.5 per cent for 775 feet	23.7 H. P.
Still start, 9.5 per cent. for 775 feet	25.7
Load about	9,000 lbs.

ENGINE TESTS :—

Cards were taken at half-hour intervals from 2 to 7 P. M., to include the heavy load of the evening.

Maximum card	124 I. H. P.
Minimum card	44 "
Mean for 5 hours	86.4 "
Friction of engine and two dynamos, circuits open	13.4 I. H. P.

The above gives :—

Average power per car	6.17 I. H. P.

The load here does not vary so much as usual owing to the large number of cars run to the engine; I have seen the line current as high as 850 amperes, *i. e.*, a 150 h. p. engine doing 215 h. p. of electrical work, to say nothing of friction load.

The insulation was about 4 megohm-miles.

COST :—

Taking the cost per car-mile as	100
we have the following :	
Carmen	67
Maintenance	18
Generating power	15
	100

And of the power house expenses :

Labor	7.3
Fuel	5.2
Oil, waste, etc	2.5
Generating power, total	15.0

ROAD "E."

There are no grades on the main line of this road; it has about 2.8 miles of double track. Eight motor cars run on an average; but for about an hour in the afternoon, ten motor cars run, six of them with tow cars. The car-mileage is 110.

POWER HOUSE :—

Two Babcock & Wilcox, 150 h. p. boilers, 64 tubes, 4″ by 18′; heating surface, 1,404 square feet; grate surface, 35 square feet. There are two 18″ by 42″ Corliss condensing engines of 150 h. p., and two 80-kilowatt shunt wound Edison dynamos.

The engines are belted to a countershaft fitted with clutches so that either or both engines can run either or both dynamos; usually one engine is used with two dynamos turning, only one supplying current; but during the time of heaviest load both dynamos are in circuit. Neither ground wire nor earth plates is used; the return is made entirely by the rails connected to each other by copper bonds.

Here coal was measured, engine cards taken every 15 minutes, and station readings every 2½ minutes from 5.40 A. M. to 11.30 P. M., that is, for the entire day's run. The results are :

Average I. H. P	66.5
Average E. H. P	52.
Average number of cars	8.
I. H. P., per car	8.3
E. H. P., per car	6.5
Shafting with two dynamos, circuits open, but fields made	24.6 H. P.
Shafting alone	15.6 "
Leaving for one dynamo	4.5 "

Time of test, 17.7 hours.

Coal	5,350 lbs.
Coal per I. H. P., per hour	4.54 "
Coal per square foot grate per hour	8.6 "

CAR READINGS :—

Cars all 16-foot; motor car weighs nearly 10,000 lbs.; trail car, 5,300.

Without trail car: About 7 stops; 14 passengers.

Mean starting current, 75 amperes; 33 per cent. of the readings zeros; E. H. P., 8.1

With trail car : About 9 stops; 20 passengers.

Mean starting current, 80 amperes; 30 per cent. of the readings zeros; E. H. P., 10.3.

Ratio of power, train to motor car, 1.27.

Both of the above are the mean of a number of trips.

The insulation was .5 megohm-miles for 8 miles of poles.

COST :—

The amount of towing is inconsiderable, only 7 car hours out of 141; so that it is taken into account only in the wages of carmen.

Taking the cost per car-mile as equal to	100
we have	
Carmen	65·5
Maintenance	12.7
Generating power	21.8
	100.

And of the power house cost:

Labor	10.
Fuel	10.
Oil, waste, etc	1.8
Generating power, total	21.8

Same measurements of the time required to stop and start the cars taken here, of which the results are given below; the timing was done by a man on the car with a stop watch.

The motor car weighed 10,000 lbs.; the tow car, 5,300.

FOR MOTOR CAR:—

A. Time car remained stationary.

Average of 77 readings	7.1 secs.
Maximum	22. "
Minimum	3. "

The readings are all close to the mean; the 22 is unique, and no other is near it.

B. Time for starting car to 2 poles' distance, that is, 250 feet.

Average of 128 readings	22 secs.
Maximum	30 "
Minimum	12 "

All very close to the mean.

C. The time for throwing off current to stop :

Average of 95 readings	12.8 secs.
Maximum	21. "
Minimum	5. "

All very close to the mean; the distances varied from 100 to 120 feet.

D. Time of running from pole to pole, that is, 125 feet; full speed.

Average of 208 readings	6.25 secs.	—13.7 miles per hour.
Maximum	7 "	12.2 " "
Minimum	5 "	17. " "

Same for motor with tow.

A. Average of 145 readings	8.25 secs.
Maximum	45. "
Minimum	2. "

No readings between 20 and 45 seconds; the readings are fairly close to the mean.

B. Average of 132 readings..............23½ secs.
Maximum..............................30 "
Minimum..............................18 "

All close to the mean.

C. Average of 111 readings.............. 11,5 secs.
Maximum.............................. 23. "
Minimum.............................. 7. "

All close to the mean; average distance 150 to 190 feet.

D. Not taken.

The following tables give most of the above results and some deductions from them:

TABLE I.

	1	2	3	4	5	6	7	8	9	10	11
Roads.	Average number of cars running.	Car Mileage.	Mean I. H. P. in station, per car.	Mean I. H. P. per car on the line.	Mean E. H. P. in station, per car.	E. H. P. on car, no tow.	E. H. P. on car, with tow.	Ratio of power; motor car + tow to motor car.	Mean starting current in amperes.	H. P. hours per car-mile.	Insulation in megohm-miles.
A.	8.24	107	8.1	5.4	6.7				82	.96	.15
B.	23.4	103				6.2	8.5	1.38	80	.84	6.9
C.	9	105				7.7			47	1.15	3.2
D.	14	105	6.2	5.2		8.6			75	1.44	.4
E.	8	110	8.3	5.3	6.5	8.1	10.3	1.27	80	1.05	.5
Ave		106	7.5	5.3	6.6	7.6	9.4	1.33	72	1.09	2.2

TABLE II.

Power on grades—average:

A.	4 per cent	17.9 H. P.
A.	6 "	22.1 "
C.	1.43 "	11.9 "
C.	3.25 "	15. "
C.	3.8 "	18.5 "
D.	9.5 "	24.7 "

TABLE III.

COST:—

Average of all the four roads in per cent.:—

Carmen	69.5
Maintenance	11.5
Generating power	19.
	100.0

Of the power house:—

Labor	11.0
Fuel	6.3
Oil, waste, etc	1.7
	19.0

Column No. 4 in Table I is the first that calls for comment. These figures are obtained from deducting the friction card from the mean I. H. P. and dividing by the number of cars. The result is roughly constant, which of course means nothing more than that the power on the car is nearly constant in spite of the varied conditions of the road, and should show in the electrical measurements as well as in the I. H. P.; for "D" and "E" the car measurements are nearly the same, viz., 8.1 and 8.6 h. p. On the other hand, taking the average power from station readings, "A" and "E" agree, viz., 6.7 and 6.5 h. p.; so the values tie up, so to speak. The electrical readings do not however, agree as closely as the mechanical.

The car readings were all taken at 30-second intervals; it was thought that this would be clear enough to give a good average, but it is not. I believe that no readings taken at equal intervals, that is, such intervals as are practicable, will give a fair average in all cases. The only right way is to have a recording meter, a wattmeter, if possible, or otherwise an ammeter, which will give a continuous record. Next to this the best plan is to to take readings at every change of the current, the time being noted; then plot the readings and integrate the curve. With 30-second readings I have got smaller power in cases when it obviously should be greater.

The chief reason for the discrepancy between car and station readings is probably the much too great frequency with which the high readings are caught; it takes the current from three to five seconds to fall from the maximum to its normal value; yet almost every high reading seems to be caught. Further, no readings are taken when car is standing at its termini; besides, the station ammeters have heavy moving parts, and hence do not respond to sudden changes.

Column 10, giving the h. p. hours per car-mile is calculated from the average of the station readings in the case of "A" and "E," together with the average car-mileage and average time of running. But in the case where no station readings were taken, the actual time of a round trip is taken; for "D," however, the car value had to be used with the average mileage, on account of the numerous delays on the run; this case shows the greatest divergence from the mean.

The mean starting current is low for "C," because there the old style Sprague motors are used which have about double the resistance of the present style. It will be noticed that these figures for starting current are much higher than those given in Mr. O. T. Crosby's recent paper, the reason being that he used an Ayrton & Perry spring ammeter; this instrument is not dead beat, and the first reading taken is far from the greatest actually attained.

The insulation is abundantly high in all cases, remembering the low line resistance; besides only 30 volts was used in measuring it, while 500 is the ordinary E. M. F. There seems to be no special difficulty in keeping the insulation high enough for this kind of work; .01 megohm-mile would be ample for a minimum figure.

The power for grades does not vary just as one might expect. For instance, for the 3.8 per cent. grade greater power is taken than for the 4 per cent.; but it must be remembered that these are far different roads with entirely different conditions of track.

The ratios of the various items in the cost of a road are rather instructive; the figure given for maintenance is, I believe, nearly correct as an average; the value for "A" is abnormally low, while for "B" it is equally high. The small part of the cost chargeable to fuel is noteworthy; doubling the number of cars on the line would involve in an ordinary station very little increase in cost of generating power; labor probably being not at all, and oil, etc., only slightly, increased.

In conclusion I may say that the roads here reported on are not selected as the best by any means, but were chosen simply as falling into a convenient arrangement of routes; one in particular is an old road, with all old style motors.

EFFECT OF ATMOSPHERIC ELECTRICITY ON TELEGRAPH LINES.

For a number of years exhaustive information on electricity in storms, with special regard to the influence of atmospheric electricity on the telegraph service and on telegraph apparatus, has been collected by the Imperial Telegraph Department, Berlin. At present, 900 telegraph offices have instructions to keep a record of the course, duration, direction, etc., of storms. From the observations made, it appears that, while not altogether free from the influence of atmospheric electricity, such influence is materially smaller in the case of underground wires compared with wires above ground. In 1888, 338 interruptions from storms were observed in underground wires, and in the above ground wires 2,375 cases of injury were reported. In regard to town telephone wires, it is worthy of remark that, notwithstanding the violence of several of the storms in the towns having a telephone system, the accidents from lightning compared with former years were strikingly few, and the assumption does not, therefore, appear to be without justification that the wires spread over the roofs affords effective protection in equalizing atmospheric electricity.

INDUCTION AND INTERFERENCE WITH TELEPHONE SERVICE FROM A TELEPHONIC STANDPOINT.[1]

BY W. J. DENVER.

I REMEMBER the first time the arc lights were exhibited in my native city, and what a tumult was caused at the telephone office. A circuit was strung up, using the ground for a return and four or five lights were placed upon it. Immediately on the starting of the dynamo, up went the lights, and down went the switchboard drops in the central station, and the confusion of tongues consequent upon the building of the tower of Babel was as the stillness of death compared to the racket on the telephone wires. I was called upon to prescribe for the patient and was obliged to look wise for awhile in order to gain time to concentrate my faculties and make a diagnosis. By a happy inspiration, more than by a reasoning process, I pronounced the disease a bad case of conduction, leakage or overflow of current caused by the use of the earth by the light' people. The remedy was evident; double the light circuit, which was done the next day, and the conduction fiend was exorcised. His twin brother, induction, still remained, but he "roared us as gently as a sucking dove" in comparison, which amelioriation of our condition was partly due to the fact that the heavy current circuit paralleled very few of the telephone lines.

As the electric light companies, whose name is now legion, increased throughout the country, the difficulties from leakage and induction naturally increased until now, especially when the low and high tension wires are on the same poles, the telephone service is more or less impaired. What would be the condition of that service if the electric light circuits were grounded instead of metallic?

Quite a number of expedients have recently been suggested for overcoming the difficulties caused by high tension currents acting through conduction and induction upon low tension circuits. The principal idea, or perhaps speaking more definitely, the one which we have heard the most about, is what is generally known as the McCluer system, which in a few words, consists in detaching the telephone wire from the earth at the distant end and connecting all wires together by means of a common return circuit to the central office or other point, at a distance, if possible, from the disturbing influence; or by a somewhat different method abandoning the use of the earth and connecting all wires together at the central office as well as at the other end. There is nothing in my judgment, particularly new about these ideas, and I am unable to think of any theoretical reasons why they should be curealls for the evils under which the telephone is prone to labor from too intimate association with its ferocious neighbors.

We have heard from time to time that most signal and triumphant successes have been scored in this, that or the other place, by means of the McCluer system, but upon investigation it strikes me that the results are a good deal like the sequel of the old story of the Three Black Crows. I do not think that the laws of electricity are as well known at present as they will be in the future, but I do think that the laws are absolute, and that when the conditions are the same the results will be the same, whether certain experiments are tried in Virginia or Massachusetts, and later on, I propose to quote the opinions of some well-known electrical scientists in order to re-enforce my opinion. In further reference to the so-called McCluer system, it may be of interest to state that it has been fully tried in the neighboring city of Cambridge in order to ascertain whether by its means the telephone service, which had been seriously interfered with by conduction and induction from a *grounded* high tension circuit, might be restored to its previous state of efficiency. We carried out the plan faithfully and at great expense. The results were not and are not satisfactory. The troubles caused by conduction which, in addition to producing an ear-splitting noise on the lines, also threw the drops in the central station, were, as far as the latter point is concerned, mainly gotten rid of, but the effect on induction troubles was virtually nil.

Personal interviews with, perhaps, 100 subscribers and balancing the opinions as to whether or not they had perceived any difference in the working of their telephones, forced us to the conclusion that, from an unbiased standpoint, we had not netted any great returns for our expenditure. I do not know of any reason why we should; theory and practice do not alwaye jibe.

As intimated above, I give, for your information, some statements and opinions of other men concerning the effect of high tension currents on the telephone, and other matters in this connection.

First, Mr. Preece, of the British Government telegraph system, when writing "On Induction Between Wire and Wire," says:

"Last year, at Birmingham, I pointed out that the electromagnetic induction between wire and wire upon lines of telegraph extended to distances much greater than was anticipated, and that effects were observed even when the wires were separated by the breadth of England. In all the following experiments the primary currents were always of rapid frequency, producing a buzzing sound, which could be easily read when audible, if sent in the Morse code and received on a Bell telephone. No difference whatever could be detected in the strength of the signals received by induction, whether the space was air or water, or a combination of air and water.

"I joined a telephone to the ends of two cables, one terminating at Lisbon, 820 miles away, the other one terminating at Vigo, 620 miles away. Signals could be distinctly heard on the telephone from the Brest cable landing, about half a mile away, and terminating at Penzance. The disturbances due to the mixed working currents on our telegraphs cannot be appreciable beyond 450 feet, but those employed in distributing electric light by means of secondary generators must extend to miles, unless they are neutralized by the two conductors being fixed parallel and close to each other."

Writing later "On Disturbances Arising from the Use of Earth for Electric Lighting Purposes," Mr. Preece says: "The magnetic field produced by a current flowing in a straight wire and returning through the earth, extends to such distances that it is quite impossible to say where, or when, or how a telephone circuit in that field would be disturbed by any changes in that current. It is quite certain that if a single conductor between Deptford and London were subject to rapid alternations under a potential difference of 10,000 volts—the current returning by way of the earth—every telephone circuit in the metropolis would be disturbed and probably rendered unworkable."

After quoting from a paper read by him before the British Association, stating the law determining the distance to which this influence extends, Mr. Preece proceeds to say that:

"It follows from this formula that currents of rapid frequency on a conductor of ten miles in length, carrying 100 amperes, might be evident at a distance of nineteen miles. It becomes, therefore, important to decide to what extent disturbing influences can be eliminated. It is well known that if either the disturbing circuit or that disturbed be constructed of two wires so close to each other and so erected that the mean average distance between the disturber and the disturbed is the same, no inductive effects are evident, for the influence on one wire is entirely neutralized by the equal and opposite effect on the other. But if this mean average distance is not equal, or if the equality of the two currents be departed from, then a disturbance will arise which will depend on the difference between the two currents and their relative distances. Hence the most perfectly silent telephone circuit becomes noisy when leaks occur in the insulation, and hence it is that the earth plays such an important part in the efficiency of the system."

Writing on "Problems in Electric Traction," Dr. Louis Bell says:—

"The effect of a traction line on all neighboring telephone lines is very marked, in some cases rendering them almost useless. The exact nature of the phenomena produced is very complicated. Listening at a telephone thus affected, it is possible to follow in considerable detail the operation of the motors. Whenever a car is started, a low hum is heard, gradually rising in intensity and pitch as the speed increases, and as the connections are shifted from step to step on the switch box. Beneath this distinct note is a confused whirring sound of lower pitch and greater intensity. The effects are clearly due to the superposition of several different periodic variations in the current and E. M. F. on the traction line. The transference of this disturbance to the telephone line depends on two quite distinct causes; first, the direct effect of induction, and second, the disturbance due to the fact that both systems are grounded at points not very far distant from each other. The relative importance of these two causes varies very widely in different places. Here (Lafayette, Ind.), most of the trouble comes from direct induction, while it is not uncommon to find nearly all of it coming from the grounds. Both causes must in general be eliminated to avoid the difficulty. But in very many cases it is desirable to use the single overhead wire, and some simple means of avoiding at once earth and induction is desirable. Clearly it is not sufficient to use the track alone for a return, or the track with an auxiliary wire beside it, as is quite usual. For the current of supply is, or always should be, divided between the trolley wire and a line wire connected with it at intervals; hence the inductive effect of this overhead system can never be balanced by an equal current along the ground by reason of unequal distance from the overhead telephone wires."

In an article lately published by Mr. Nelson W. Perry, of Ohio, he quotes some published opinions of Mr. Sprague's, of the Sprague Electric Railway Co., and in reply thereto says:—

"One thing I found out, and that is that it is not safe to generalize as Mr. Sprague has done. We cannot say that in one case either induction or conduction will be the predominating disturbing element until we have actually tested the case in question. This is so, not because the nature of the laws governing induction are imperfectly understood, but because there may be many modifying causes that cannot certainly be predetermined either as to their existence or extent.

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[1] Abstract of a paper read before the Boston Electric Club.

"Now the McCluer device is one by which it is sought to remove the telephone ground to a point so far removed from the seat of disturbance that conduction currents cannot enter upon the telephone lines. It is not claimed by Mr. McCluer, nor is there any theoretical reason whatever for claiming, that the McCluer device can, or will, abate in any way disturbances due only to induction.

"A telephone subscriber located at a considerable distance, say a mile or two, from the electric railroad, will, if his telephone have a ground at that point, enjoy the fullest benefits of the McCluer device. As many of the telephone lines running parallel with the electric railroad extended to this distance, and in some cases to much greater distances from the line of the railway, and were still exceedingly noisy, I thought it not worth the while to attempt an experiment with a specially prepared McCluer wire. In fact, as four of the wires extended to a distance of not less than 17 miles beyond the terminus of the railroad and were still exceedingly noisy, I would have had to go a long distance indeed to have found a better point to ground my wire. It was proof conclusive that the McCluer device would do no good in that particular case. I also demonstrated another point that I did not know before, but which, it seems, was known to others more familiar with the subject than I, and which afterward came out in the expert testimony at the trial, viz., that two quiet circuits, when united into one, may become quite noisy.

"But I was very much mystified by the difference in degree to which telephones seemingly similarly situated were affected. Every rule and probability seemed to be set at defiance. As I have said, some telephones, whose grounds were furthest removed from the railroad, were noisier than some whose grounds were nearer to it. A telephone whose wire ran parallel with the road for a quarter of a mile was sometimes noisier than one whose wire ran parallel for half a mile; but what was more perplexing, it was not always the case. Two telephones, whose wires were parallel for equal distances, were usually affected to perceptibly and often markedly different degrees. Sometimes, of two telephones leaving the street at the same pole, the one going east was the worse; at others that going to the west gave most trouble. Sometimes it was the one that ran into low ground that responded the loudest.

"Mr. Sprague argues that the induction cannot become prominent because the wires are not nearer than from 20 to 30 or 40 feet, and seldom parallel for distances greater than two or three miles. One of my experiments shows that if they are parallel for half a mile at this distance, the disturbance is quite marked. And furthermore there are several patents that have met with more or less success experimentally for telegraphing to and from moving trains. This is accomplished in exactly the same way as the telephonic troubles under discussion are caused, and in such appliances of the principle and induction the length of parallelism is not two or three miles, but limited to the length of a single railroad car, or at most to the length of a railroad train.

"Mr. Sprague furthermore says: 'The current used upon this wire (the trolley wire), is not of the character which distinguishes some of the arc light circuits, but is of more or less even flow, and the abrupt and large changes due to the change of load on the motor are comparatively infrequent. There is a very small change due to the variation of resistance of the armature of the motor, because of the different relative positions of the commutator blocks under the brushes, and there is likewise a variation due to the slight but rapid changes of counter electromotive force set up by the motor when running.'"

Mr. Perry in reply says: "Variations in current due to such cases is many times too slow to produce an audible sound, but I do not think it is largely due to the very rapid and inevitable changes of current due to the varying contact between the wheel and the dirty track over which it is rapidly moving, and, in case the electrical connection between the motor and the track be by means of the gear, by the unavoidable variation of contacts between these parts."

As we have dwelt at considerable length on the difficulties to which the telephone is subjected in consequence of its sensitiveness and adaptability for picking up extraneous sounds which are not at all desirable or necessary in the proper transaction of the business, it may be well to point out, if possible, what might be done towards eliminating these troubles. It is easy to say the telephone people should use metallic circuits; much easier to say, than it is to do it. A real good metallic circuit for telephonic use can be made by twisting two insulated copper wires together. I do not know of anything that will equal in efficiency this plan. It is very evident that this copper wire needs some extra protection, and that is obtained generally by using a lead pipe to encase the cables made up of copper wires. This arrangement will do very well when laid in underground conduits, or, as has been done in a few instances, by making up a light weight cable and suspending it from poles; but it is utterly impracticable to use cables or twisted copper wires in all cases. Underground wires must connect at some point with overhead wires, and regarding the working of wires underground Mr. J. J. Carty in his very able paper recently read before the New York Electric Club says:

"This putting wires underground in cities is the only bar to a universal system of telephony, and if direct air lines were built, New York and Chicago would be placed within speaking distance of each other at once. To place telephone wires underground and maintain the same efficiency as in overhead lines, would require an insulation on each wire of over two feet in thickness, and instead of getting 50 pairs of wires into a three-inch pipe, as at present, a tunnel occupying half the street would be required for one cable alone. When we consider that a telephone office of even moderate size would require about a hundred such gigantic cables, it is seen how almost hopeless the case becomes."

Lastly, in addition to the fact that in order to obtain the very best results, not only are the twisted wires a necessity, but a balance must be maintained between each side of the metallic circuit, and the insulation should be as good on one side as on the other. A loss of insulation will certainly result in a noisy circuit.

Now, leaving out of consideration altogether the points of dispute as to which interest, if any, should own the earth, or as to whether this line, or that line, was the first comer, we can think of what, in a general way, may be a cure for the induction and conduction disease.

And as we have dwelt upon what might be done by making the telephone wires up in metallic circuit, we can also point out some other way. Low tension wires and high tension wires should be separated from each other as much as possible. I think there can be no dispute about that. Telephone wires should be placed on one side of the street and high tension wires on the opposite side of the street, if no greater distance can be attained. The main troubles arising from conduction will manifestly be gotten rid of in this way. The probable interference from induction still remains to some extent. That, however, can be materially lessened by having both sides of each high tension circuit placed as near to each other as is practicable, and with frequent transpositions of each circuit—the placing of lamps on each side in order to preserve as nearly as is possible an electrical balance, and carrying in a loop both sides of the circuit on which lamps are to be placed on a street, and not on the direct line—will certainly tend to lessen the troubles under which the telephone labors. I do not know that it is necessary to dwell upon what might be done with grounded circuits carrying a high tension current, except to say that there are good reasons why there should not be any such circuits.

THE KANSAS STATE ELECTRIC ASSOCIATION.

A meeting of the representatives of the various electric light companies doing business in Kansas, was held at Topeka, and organized a state association of central station companies under the name of the Kansas State Electric Association, to promote the legitimate growth of the business; the securing of uniformity in regulations for inspection of construction and inside wiring; also underwriters' rules for insurances, and to give such assistance and advice to the companies in its membership as may be consistent with the general interests of the industry and the benefit of consumers. The following officers were elected: President, L. A. Beebe, Hutchinson; vice-president, G. F. Parmelee, Topeka; second vice-president, J. C. Fuller, Winfield; secretary and treasurer, R. C. Johnston, Lawrence.

MANUFACTURE OF PROJECTILES BY ELECTRIC WELDING.

ANOTHER of the many uses to which electric welding can be put, has been prominently brought forward in the shape of rumors well founded that the Thomson Electric Welding Co. would commence the manufacture of projectiles by the welding process.

It has heretofore been remarked that the Thomson Electric Welding Co. had taken out patents which might form the basis for the organization of a new welding company, but particulars have not until now been accessible. It appears that about four months since Lieutenant W. M. Wood of the United States navy, who is on leave of absence, and associated with the Thomson Welding Co., conceived the idea of manufacturing projectiles by the electric welding process, with a view to secure better results than have been heretofore obtained by any other process, and at a saving of expense. The idea was wrought out, and patents for this purpose have been granted. Heretofore the government has had to bore solid metal at great cost. By the process as governed by the patents a steel tube of the proper length and thickness is welded to the head and then to the butt of the shell, thus in a few moments accomplishing what now requires hours of costly machine labor. The process is varied according to the class of shell or shrapnel to be manufactured, all details of which are covered by the patents which the company holds.

The Thomson Electric Welding Co. has taken out similar patents in all foreign countries, and that department will receive attention later. The old, or parent, electric welding company is arranging to supply welding plants at the navy yards in Brooklyn, Norfolk and Washington, and a dispatch reports that an item of $12,000 has been reported to the House by the naval committee in the appropriation bill for a chain welding plant for the Charlestown Navy Yard.

THE STANDARD TYPE OF ELECTRIC LIGHT AND POWER STATION.

The Electric Mutual Insurance Co. has now been formed in Boston, with the following officers: Stephen E. Barton, *president;* Everett W. Burdett, *vice-president;* Herbert H. Fairbanks, *secretary and treasurer;* William Brophy, *chief inspector*. The *directors* are, F. A. Gilbert, president Boston Electric Light Co., Boston; C. L. Edgar, manager Edison Electric Illuminating Co., Boston; E. W. Burdett, treasurer Citizens' Electric Light Co., East Boston; General Benjamin F. Peach, Jr., assistant treasurer Thomson-Houston Electric Co.. Boston; T. C. Bates, director Worcester Electric Light Co., Worcester; Elisha Morgan, president United Electric Light Co., Springfield; Robert B. Taber, manager New Bedford Gas Light Co., New Bedford; Thomas T. Robinson, contractor, president and director of several electric light companies, Boston; Stephen E. Barton, Boston; William Brophy, Worcester.

The requirements of the company for the construction, equipment and maintenance of a standard electric light or power station, are:—

CONSTRUCTION OF BUILDING:

Material of Walls.—It should be built of brick, or other fire-proof material, and not over two stories high. A wire tower, or basement will not be regarded as a story.

Material of Roof.—The roof should be covered with metal, slate, composition, tar and gravel, or other non-inflammable material, and the cornice should be brick, metal, or open and plain. Boxed or cased wooden cornices are undesirable.

Wooden sheathing should not be placed on roof timbers or rafters so as to leave concealed space, and vacant attics should be avoided. With either pitch or flat roofs, it is desirable that no attic or blind space be left.

Material of Floors.—The floors (if not made of some fire-proof material) should be at least three inches thick, preferably of two or three-inch plank, grooved and splinted, with one-inch jointed hardwood for a top flooring. Maple, birch, beech, or hard-pine are desirable for the "top flooring," as they do not readily absorb oil. If the station is more than one story high, the floors above the ground floor should be free from all openings, if possible, in order that a fire originating on one floor would not readily communicate to another through the openings in floors.

Stairs and Elevators.—Stairs and elevators should be placed outside, where possible, or if inside the building, stairs should be completely partitioned off from the room below, with some hardwood or other slow-burning material, and provided with self-closing doors hung at the bottom of the flight. Elevators should not be cased up but should be provided with approved, self-closing hatches.

Inside Finish.—There should be *no* inside finish such as sheathing, lath and plaster, or any finish that would leave concealed spaces between outer and inner walls, or add inflammable material to the station. If the building is of brick, the inside should be left perfectly plain, being finished with paint if necessary to cover the roughness. If constructed of wood, the timbers and boarding should be dressed on the inside if a rough finish is undesirable. But by all means the inside walls and ceiling should be left plain and open, sacrficing beauty for safety, always.

Boiler-House.—Boilers and boiler chimney should be cut off from the engine and dynamo-rooms by a fire-wall (not less than eight inches if brick, and thicker according to the character of building) with as few openings or communications as possible, and such openings should be protected with heavy, tin-clad doors (or shutters, if windows). The cut-off wall should extend high enough between the boiler-room and engine or dynamo-room to effectually stop communication of fire between them.

No wood should be in contact with any part of the boiler-setting, and roof or floor should be three feet or more from boilers.

Fire-Doors and Shutters.—An approved fire-door or shutter is made of two thicknesses of one-inch matched boards, a layer of asbestos between boards, and nailed together with clinch-nails. The boards should run diagonally, the two sides in opposite directions, to give strength. The covering should be with "I–C" tin, 14x20, laid on with flat lock, securely nailed under the lap, the covering to commence at the edge of the door, and "locked in" to the centre of the side of the door. Both sides and the edges should be covered, and great care taken that all joints lock. Sheet tin should be used, and *not* sheet iron, the latter being too heavy to allow of lock jointing. The doors or shutters should be hung with substantial hinges, preferably wrought iron, bolted through the door and equally as securely fastened to the door-frame or building. The frame, or casing of the door, should be as securely tin-clad as the door. The door, or shutter, should be provided with a strong latch to hold it firmly in place.

Doors should be self-closing to insure their being kept shut. If *necessary* to have them open for ventilation or other purpose, they should still be provided with the self-closing apparatus, but held open by a long hook, or stay, made in two sections and joined together by a soft solder that will yield at a temperature of 150 degrees Fahr., and allow the door to automatically close, or by some similar arrangement.

Whether fire originates in the boiler-room or the engine and dynamo-room, the efficient fire-wall is valuable in saving from injury either the one or the other, and thereby lessening the delay and loss incident to a destruction of the whole plant.

Chimney and Iron Stack.—If the chimney is of brick, it should never be less than two bricks thick, with air-space, and should be free from contact with wood, where possible.

If an iron stack is used, and it goes through a wooden roof (or floor), the wood should be cut away at least one foot all around, and a metal collar placed over the opening. This collar should not come within three or four inches of the iron stack, but should be turned up on the inside edge, flange-like, around the stack. Above the collar should be placed a hood sufficiently wide to prevent storms from beating in.

Such an arrangement will, in addition to being safe, serve as a good ventilator for the boiler-room.

Automatic Sprinklers in Lieu of Fire-Wall.—Where a fire-wall, as above described, is impracticable or undesirable for any reason, an approved equipment of automatic sprinklers thoroughly covering the area of the boiler-room will be accepted in lieu of such fire-wall. The pipe supplying the sprinklers must be of sufficient size to adequately supply all of the automatic heads at one time, upon the assumption that such an emergency may arise, The water supplying the pipes must come from some water-works, or other gravity source with sufficient head and supply to give a satisfactory pressure and quantity.

The gate-valve admitting the water to the sprinkler pipes should be securely fastened *open*, and sealed to insure its being *always open*. An auxiliary supply to the sprinklers should be provided by attaching the boiler feed-pump, or any other forcing pump of sufficient capacity, on the premises; the pump to be used in case the gravity supply should happen to be shut off when needed.

(Specific information in relation to sprinklers and supply will be given if called for.)

ELECTRICAL EQUIPMENT.

Insulation of Dynamos.—All electric generators should be well insulated on dry floors, or dry wood base frames, and if the latter, they should be well painted in order that they may not absorb moisture or oil, and they should at all times be kept free from oil by frequent wiping. Dynamos should be provided with water-proof covers, to be kept on them when not running.

Wiring.—All wiring from dynamos, generators, or exciters, to switch-boards, rheostats, or instruments and devices of any nature, and from thence to outside lines, should be run in *plain sight* and wholly on non-combustible insulators such as glass, or porcelain, or on hard rubber hooks. Where any wires pass through wood (either floors, partitions, or walls), they should be absolutely free from contact with the wood by the use of non-combustible, or non-inflammable insulating tubes, such as glass "floor insulators"; wooden cleats should never be used in a station.

Separation of Wires.—Wires of opposite polarity, or the same polarity where any great difference of potential exists, should be rigidly kept apart sufficient distance to preclude the possibility of their coming in contact.

'Bus Bars.—'Bus wires, or bars, and all connections thereto, should be ample in carrying capacity to prevent heating under any normal conditions, and they should be supported on non-combustible insulators, absolutely free from contact with wood or other inflammable material.

Connections, Splices.—All wire connections or splices should be equal in carrying capacity to the wire itself, and they should be soldered if necessary to secure permanent good contact and conductivity.

Wires Under Floors.—Where possible it is preferred that wires should be run from dynamos directly up to proper insulators overhead, rather than down, through the floor and up again to switchboards, etc. If it should be impossible to avoid running them down through the floor, the best of insulation, that will not yield to the solvent action of oil, and also glass floor insulators must be used. The space under the floor should be ample to admit of easy examination and good ventilation, and the wire must be specially insulated and run on non-combustible insulating supports.

Switch-Boards.—All switch boards should be set out from the walls or partitions, so that free access can be had all around them. They should be made of non-combustible material, such as slate or the like; or, if made of wood, they should be "skeleton" in form, and of oak, hard pine, or other slow burning wood. They should never be built in compact, solid form, extending from floor to ceiling, but should be in such form that no arc or fire could occur without being discernible from any part of the room.

All wiring on the switch-board (if of wood) should be on glass or porcelain.

Rheostats.—Unless the case or frame surrounding rheostats, or similar instruments, is made of non-inflammable material, they should be set out from the woodwork by placing porcelain knobs, or the like, behind them.

It is preferable that all such devices be placed on the switch-board, or on non-combustible walls.

Feeder Equalizers.—The frames of feeder equalizers should be of iron or other non-combustible material, and they should be set at least one foot from any wood or other inflammable material. Where they are grouped together, or cannot readily be arranged as provided above, they should be separated by asbestos or cement from wooden floors or walls, and at once protected by a sufficient number of automatic sprinkler heads with gravity supply of water constantly on them.

Wire Tower.—If a tower is used for wires entering the station, it should be easy of access for inspection, sufficiently large to prevent crowding and dangerous crossing of wires, and the wiring should be only on non-combustible insulators; glass, or other equally good, non-inflammable insulating tubing to be used where wires pass through the sides.

Lightning Arresters.—Both sides of every circuit should be provided with lightning arresters, placed in some location in plain sight, preferably on the switch-board away from woodwork. The ground wire should be of large size. A "saw-tooth" arrester should not be used on any circuit of over 125 volts.

All arresters for currents of over 125 volts should be so constructed as to instantly break the arc after the discharge has passed off.

FIRE APPARATUS.

Gravity Supply of Water.—Every station should be supplied with water from some gravity source, such as public water-works, or a tank with not less than 2,500 gallons, elevated enough to furnish pressure necessary to reach any part of the building.

Size of Pipe.—The outlet pipe from the water-works or tank to the hydrants should not be less than two inches in diameter, and larger according to the size of the station.

Hydrants.—If the engine and dynamo room are separated from the boiler-room by fire-wall and fire-doors, there should be a hydrant on each side of the wall, located at some accessible point where it would command all parts of each room and could be readily reached and controlled from the inside or outside.

Hose.—The hose on these inside hydrants should not be larger than 1½ inch diameter, and need not be larger than 1 inch. Hose of small size can be more quickly and easily handled by one person. It should be the best in quality, say cotton woven and rubber lined, and should be constantly attached to the hydrant, and kept on a proper shelf or hose rack, lapped one fold upon another so that it can be taken off without twist or kink. It should never be coiled up, except the coil is started at the middle of the length, so that the two ends will be together; otherwise when uncoiled it will contain a twist for every convolution. The hose at each hydrant should be of sufficient length to reach all parts of the rooms it is designed to protect, but not so long as to be cumbersome. It is well to have an extra length or two in reserve.

Nozzles.—The nozzle should be small at the delivery end, not over one-half or three-eighths inch, in order to give greater pressure, and there should be no cock or valve in it, as they are liable to stick from corrosion and other cause.

Valves.—The valve for letting on water should be at the hydrant where the hose is kept attached, and it should be occasionally tried to see that it works freely.

Secondary Supply of Water.—As an auxiliary water supply, the hydrants should be connected with the most powerful forcing pump on the premises, by a pipe of the full capacity of the pump or of the hydrants. Public water sometimes gets shut off, or its pressure becomes reduced, and tanks or other sources may become exhausted; therefore it is important to have pumps attached to hydrants.

Tell-tale for Tanks.—If a tank is used, a "tell-tale" should be arranged to indicate to the proper person when the water becomes lowered by evaporation or otherwise.

Fire-pails.—Each floor must be provided with not less than three fire-pails (and more if a large room), which should be constantly filled with water unless a supply is on hand in the room, such as from faucets in sink, or barrels kept full. The pails should be of galvanized iron, fibre, or some similar material that will not shrink and become unserviceable in time, and they should be kept exclusively as fire-pails.

Fire Extinguishers.—In the absence of a gravity supply of water, the inside hydrants must be supplied from the boiler pump, or other forcing pump, and the station should be supplied with two or more fire extinguishers, similar to the modern "Babcock Pony Extinguisher."

Outside Protection.—If the station is located in a town having a Fire Department with water-works or steamers, or both, a special hydrant (if water-works) should be secured and set within 200 feet of the building, unless there exists one within that distance. If the service consists of a steamer or steamers without water-works, a reservoir or other supply for the steamer should be located within the distance above named.

Fire-Alarm.—If there exists an electric fire-alarm system in the place, a special box should be secured and located at the station, unless there is one within a couple of minutes' reach, and a key (unless it is a keyless box) should be kept at the station. In the absence of any electric fire-alarm system, a signal, such as blowing the whistle, should be agreed upon with the Fire Department in order that a call for help may be quickly responded to.

Exposures.—If there are other exposing buildings or hazards within 50 feet, the station should be protected by tin-covered shutters at the windows or other openings on the exposed sides, if it is built of brick or has other fire-proof walls. If the station is built of wood, the exposure may sometimes be reduced by running a line of open sprinkler-heads along the top of the exposed side; the pipe supplying the heads to be of ample size to give them all full pressure at once, and it should be connected to some gravity source of water or force-pump, with a valve to open and let on the supply in case of fire in the exposing building.

Dwellings will not, ordinarily, be regarded as exposures.

CARE AND ATTENDANCE.

Attendance.—The station should not be left alone any considerable time, and a competent man should be kept constantly in the dynamo and engine rooms when in operation.

Oily Floors.—As oil has been the most prolific cause of the spread of fires and the consequent serious damage in electric stations, it will be required that the floors and machines be kept as free as possible from the accumulation of it on them.

Washing Floors Weekly.—If dynamos are properly insulated on dry, painted wooden base frames, and if the wiring is properly done by carrying conductors up direct from the dynamos to insulators overhead, it will be quite safe to wash the floors every week, and thereby keep them free from oil. Washing may be safefy done where wires pass down through the floors, if good water-proof insulation and glass-floor insulators are used.

No wire should ever be laid *in* the floor, or under moulding or boxing on the floor.

Waste.—Oily waste should be carefully deposited in metal waste cans, kept in the engine and dynamo room for that purpose. It should never be laid on the floor, or in wooden boxes.

Oil-room.—Oil tanks should be kept in a room with cement or other non-absorbent and non-inflammable floor, or should be provided with metal pans under them, and any accumulation of open oil in pans or about the station should be avoided.

NOTE.

After every precaution has been taken to avoid fires happening, it must be conceded that they are liable to happen; and the aim of this Company is, to reduce the chances of such accidents, by approved construction of the building and safe electrical installation, and then, recognizing the fact of the inevitable fire, to have the station kept as free as possible from inflammable substances, particularly as to oil around engines and dynamos, and so equipped with ready and efficient fire-extinguishing apparatus that the least possible damage will be done. If everthing fails, and the station is destroyed, it should be fully insured, but, by neglecting precautionary measures the price of full insurance is so large as to preclude it. If it can be secured at *cost* after all precautions are taken, it should be carried by every station-owner.

LAND LINES AND LIGHTNING.

The *Journal Télégraphique*, of Berne, gives a table showing the various accidents which occurred to telegraph lines during the year 1888. From this list we take the casualities due to lightning in the undermentioned countries.

	Percentage of Casualities to		
Countries.	Posts.	Insulators.	Instruments.
Belgium	0·071	0·004	0·315
Denmark	0·035	0·009	1·491
France	0·070	0·019	0·675
Germany	0·055	0·001	1·613
Holland	0·071	0·011	1·851
Italy	0·220	0·042	2·222
Switzerland	0·035	0·005	3·030

It will be noticed that lightning damaged the greatest number of posts and insulators in Italy, and by far the greatest number of instruments in Switzerland. The least damage was caused to posts in Denmark and Switzerland, to insulators in Germany, and to instruments in Belgium.

MAGNETISM.

BY DR. JOHN HOPKINSON, F.R.S.

(Continued from p. 219.)

In speaking of the properties of bodies which, like manganese steel, are slightly magnetic, it may be well to enter here a caution. But little that is instructive is to be learned by testing filings, or the like, with magnets, as these show but little difference between bodies which are slightly magnetic and those which are strongly magnetic. Suppose the filings to be spheres, in the following table are given comparative values of the forces they would experience in terms of μ, if placed in a magnetic field of given value, μ having its ordinary signification—that is, being the ratio of the kick on the galvanometer when a ring is made of the material of the filing, to the kick if the ring is made of a perfectly non-magnetic material:

μ.	Attraction.	
1	0	Non-magnetic body.
1.47	0.18	Manganese steel with 12 per cent.
3.6	1.2	Manganese steel with 9 per cent.
5	1.5	
10	2.1	
100	2.8	
1,000	2.98	

Now bodies in which μ is so small as 3.6 belong distinctly to the non-magnetic class; but the test with the magnet would very markedly distinguish them from manganese steel with 12 per cent. of manganese. The distinction, however, between $\mu = 3.6$ and $\mu = 1,000$ is comparatively small; whereas, under the conditions of experiment, μ is much more than 1,000 for most bodies of which iron is the principal constituent.

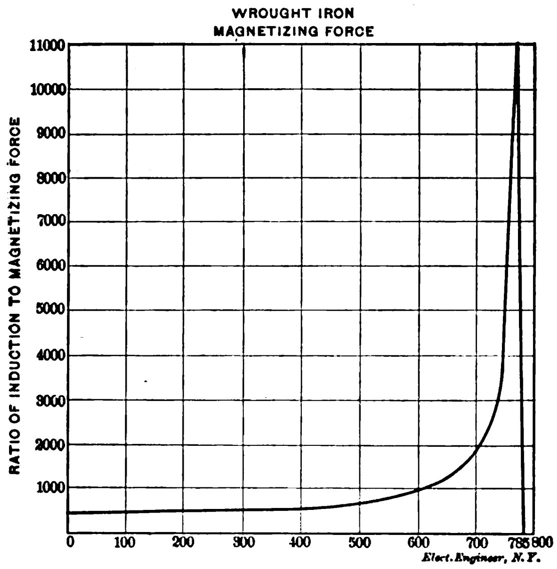


FIG. 8.

The effect of stress on the magnetic properties of iron and nickel have been studied by Sir W. Thomson. A fact interesting from a broad and general point of view is that the effects of stress are different in kind in the case of iron and nickel. In the case of iron, for small magnetizing forces in the direction of the tension, tension increases the magnetization; for large forces, diminishes it. In the case of nickel the effect is always to diminish the magnetization.

When one considers that the magnetic property is peculiar to three substances—that it is easily destroyed by the admixture of some foreign body, as manganese—one would naturally expect that its existence would depend also on the temperature of the body. This is found to be the case. It has long been known that iron remains magnetic to a red heat, and that then it somewhat suddenly ceases to be magnetic, and remains at a higher temperature non-magnetic. It has long been known that the same thing happens with cobalt, the temperature of change, however, being higher; and with nickel, the temperature being lower. The magnetic characteristics of iron at a high temperature are interesting. Let us return to our ring, and let us suppose that the coils are insulated with a refractory material, such as asbestos paper, and that the ring is made of the best soft iron. We are now in a position to heat the ring to a high temperature, and to experiment upon it at high temperatures in exactly the same way as before. The temperature can be approximately determined by the resistance of one of the copper coils. Suppose, first, that the current in the primary circuit which we use for magnetizing the ring is small; that from time to time, as the ring is heated and the temperature rises, an experiment is made by reversing the current in the primary circuit and observing the deflection of the galvanometer needle.

At the ordinary temperature of the air the deflection is comparatively small; as the temperature increases the deflection also increases, but slowly at first; when the temperature, however, reaches something like 600° C., the galvanometer deflection begins very rapidly to increase, until, with a temperature of 770° C., it attains a value of no less than 11,000 times as great as the deflection would be if the ring had been made of glass or copper, and the same exciting current had been used. Of course a direct comparison of 11,000 to 1 cannot be made; to make it we must introduce resistance into the secondary circuit when the iron is used; and we must, in fact, make use of larger currents when copper is used. However, the ratio of the induction in the case of iron to that in the case of copper, at 770° C., for small forces is no less than 11,000 to 1. Now mark what happens. The temperature rises another 15° C.; the deflection of the needle suddenly drops to a value which we must regard as infinitesimal in comparison to that which it had at a temperature of 770° C.; in fact, at the higher temperature of 785° C. the deflection of the galvanometer with iron is to that with copper at a ratio not exceeding that of 1.14 to 1. Here, then, we have a most remarkable fact: at a temperature of 770° C. the magnetization of iron 11,000 times as great as that of non-magnetic substance; at a temperature of 785° C. iron is practically non-magnetic. These changes are shown in Fig. 8. Suppose now that the current in the primary circuit which serves to magnetize the iron had been great instead of very small, In this case we find a very different order of phenomena. As the temperature rises the deflection on the galvanometer diminishes very slowly till a high temperature is attained; then the rate of decrease is accelerated until, as the temperature at which the sudden change occurred for small forces is reached, the rate of diminution becomes very rapid indeed, until, finally, the magnetism of the iron disappears at the same time as for small forces. Instead of following the magnetization with constant forces for varying temperatures, we may trace the curve of magnetization for varying forces with any temperature we please. Such curves are given in Figs. 9 and 10. In the one diagram, for the purpose of bringing out different points in the curve, the scale of abscissæ is 20 times as great as in the other. You will observe that the effect of rise of temperature is to diminish the maximum magnetization of which the body is capable, slowly at first, and rapidly at the end. It is also very greatly to diminish the coercive force, or to increase the facility with which the body is magnetized. To give an idea of the magnetizing forces in question, the force for Fig. 8 was 0.3; and as you see from Figs. 9 and 10, the force ranges as high as 60. Now the earth's force in these latitudes is 0.43, and the horizontal component of the earth's force is 0.18. In the field of a dynamo machine the force is often more than 7,000. In addition to the general characteristics of the curve of magnetization, a very interesting, and, as I take it, a very important, fact comes out. I have already stated that if the ring be submitted to a great current in one direction, which current is afterwards gradually reduced to zero, the ring is not in its non-magnetic condition, but that it is, in fact, strongly magnetized. Suppose now we heat the ring, whilst under the influence of a strong magnetizing current, beyond the critical temperature at which it ceases to have any magnetic properties, and that then we reduce the current to zero, we may in this state try any experiment we please. Reversing the current on the ring, we shall find that it is in all cases non-magnetic. Suppose next that we allow the ring to cool without any current in the primary, when cold we find that the ring is

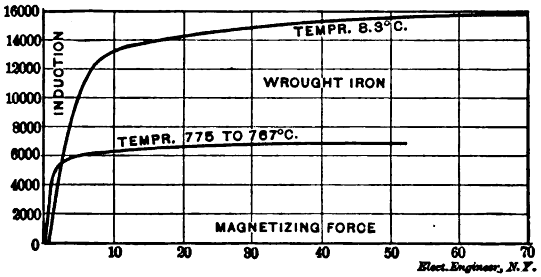


FIG. 9.

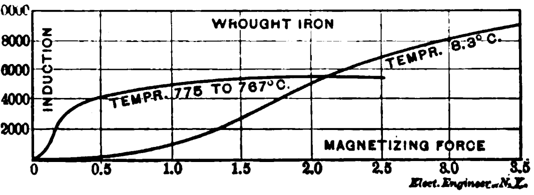


FIG. 10.

magnetized; in fact, it has a distinct recollection of what had been done to it before it was heated to the temperature at which it ceased to be magnetic. When steel is tried in the same way with varying temperatures, a similar sequence of phenomena is observed; but for small forces the permeability rises to a lower maximum, and its rise is less rapid. The critical temperature at which magnetism disappears changes rapidly with the composition of the steel. For very soft charcoal iron wire the critical temperature is as high as 880° C.; for hard Whitworth steel it is 690° C. (*To be continued.*)

THE NEW DAFT ROAD AT SUNBURY, PA.

The Daft Electric Light Co., of 115 Broadway, have recently completed a most interesting electric railway installation for the Sunbury and Northumberland Street Railway Co. This road, which is to be operated on the overhead system, crosses a bridge a mile long across the Susquehanna river, and the Reading and Lehigh Valley Railroads have contracted with the electric road for the transfer of expressage, passengers, etc. The track is well built, having been laid with Johnson girder rail, and a speed of 25 miles an hour will be made. Three trains of cars will be run. The motor cars are equipped with the 30 h. p. individual motors which the Daft company have adopted as their standard. The power plant has been equipped in duplicate, in engine units of 125 h. p. each, with generator capacity to correspond. Altogether the road is a striking piece of work, and it is attracting considerable attention.

A LIST OF THOMSON-HOUSTON ELECTRIC RAILWAYS.

THROUGH the courtesy of the Thomson-Houston Electric Co., we are enabled to print a complete list of their electric roads up to April 1.

ROADS IN OPERATION.

Location.	Name of Road.	No. of motor cars.	Length of track in miles.
Alliance, O	Alliance Street Railway Co	8	2
Atlanta, Ga	Atlanta & Edgewood St. Ry. Co	4	4.50
Atlanta, Ga	Fulton County St. Ry. Co	10	9
Ansonia, Conn	Derby Horse Railway Co	4	4
Albany, N. Y	Watervliet Turnpike & R. R. Co	16	10
Americus, Ga	Americus Street Railway Co	4	5.50
Bangor, Me	Bangor Street Railway Co	5	3
Boston, Mass	West End Street Railway Co	127	112
Cincinnati, O	Mt. Adams & Eden Park Inc. Ry	4	16
Cleveland, O	Brooklyn Street Railway Co	41	3.50
Chattanooga, Tenn	Chattanooga Elec. St. Ry. Co	2	
Cincinnatti, O	Colerain Avenue Railway Co	8	5
Council Bluffs, Ia	Omaha & C. B. Ry. & Bridge Co	24	9
Crescent Beach, Mass	Lynn & Boston Railroad Co	1	1
Denver, Col	Denver Tramway Co	16	10
Decatur, Ill	Citizens' Electric Street Ry	9	5
Danville, Va	Danville Street Car Co	6	2
Des Moines, Ia	Des Moines Elec. Railway Co	19	8.50
Harrisburg, Pa	East Harrisburg Passenger Ry	1	
Joliet, Ill	Joliet Street Ry Co	8	2.70
Kansas City, Mo	Metropolitan St. Ry. Co	18	5.50
Kansas City, Mo	Vine Street Railway Co	6	3
Kansas City, Mo	The North East Street Ry. Co	10	7
Lynn, Mass	Lynn & Boston R. R. Co., Highland Line	6	1.80
Lynn, Mass	Lynn & Boston R. R. Co., Myrtle St. Line	4	3
Lynn, Mass	Lynn & Boston R. R. Co., Nahant Line	1	.75
Louisville, Ky	Central Passenger Railway Co	12	7.25
Macon, Ga	Macon City & Suburban Ry. Co	8	8
Minneapolis, Minn	Minneapolis Street Ry. Co	10	8
Nashville, Tenn	City Electric Ry. Co	10	3.50
No. Adams, Mass	Hoosac Valley Street Ry. Co	3	6
Nashville, Tenn	McGavock & Mt. Vernon Horse Ry. Co.	26	5
Newburyport, Mass	Newburyport & Amesbury Horse Ry. Co.	3	6.50
Newport, R. I	Newport Street Ry. Co	6	4.50
Omaha, Neb	Omaha Motor Railway Co	30	26
Ottumwa, Ia	Ottumwa Street Railway Co	4	4.50
Ottawa, Ill	Ottawa Electric St. Ry Co	8	7
Pittsburgh, Pa	Second Avenne Pass. Ry. Co	10	10.06
Plymouth, Mass	Plymouth & Kingston St. Ry. Co	3	4.50
Peoria, Ill	Central Railway Co	15	13
Quincy, Mass	Quincy & Boston Street Ry. Co	4	7.50
Richmond, Ind	Richmond Street Ry. Co	6	4
Revere, Mass	Boston & Revere Elec. St. Ry. Co	6	4
Rochester, N. Y	Rochester Electric Ry. Co	9	6.20
Scranton, Pa	Scranton Passenger Ry. Co	4	2
Scranton, Pa	Scranton Suburban Pass. Ry. Co	10	5
Scranton, Pa	Nay Aug Cross-Town Ry. Co	3	1.50
Seattle, W	Seattle Electric Ry. & Power Co	13	5
Southington, Conn	Southington & Plantsville Ry. Co	2	1.80
Spokane Falls, W	Ross Park Street Ry. Co	20	14.50
St. Paul, Minn	St. Paul City Railway Co	4	6
St. Paul, Minn	Grand Ave. Line	4	6
St. Louis, Mo	St. Louis & E. St. Louis Electric Ry. Co.	6	2
Syracuse, N. Y	Third Ward Street Ry. Co	8	4
Toledo, O	Toledo Electric Railway Co	3	2.50
Topeka, Kan	Topeka Rapid Transit Co	30	20
Victoria, B. C	National Electric Tramway & Ltg. Co.	6	4
Victoria, Aus	Doncaster & Box Hill Tramway Co	1	2
Wichita, Kan	Riverside & Suburban Ry. Co	6	5
Washington, D. C	Eckington & Soldiers' Home Ry. Co	10	3
Wheeling, W. Va	Wheeling Railway Co	5	10
	61 Roads.	665	463.56

ROADS UNDER CONTRACT.

Location.	Name of Road.	No. of motor cars.	Length of track in miles
Attleboro, Mass	Attleboro, No. Att. & Wrentham St. Ry.	5	6.50
Auburn, N. Y	Auburn Electric Railway Co	3	3
Albany, N. Y	The Albany Railway Co	22	14
Augusta, Me	Augusta, Hallowell & Gardiner Ry Co.	3	3
Boston, Mass	West End Street Railway Co	130	18
Brooklyn, N. Y	Coney Island & Brooklyn R. R. Co	12	116
Bremen, Germany	Bremen Tramway Co	6	2
Dallas, Tex	No. Dallas Circuit Ry. Co	4	3.80
Fort Worth, Tex	North Side Railway Co	15	15
Gloucester, Mass	Gloucester Street Railway Co	8	5
Indianapolis, Ind	Citizens' Street Ry. Co	10	6.50
Knoxville, Tenn	Knoxville Street Railroad Co	5	3.40
Kearney, Neb	Kearney Electric Railway Co	2	8
Lynn, Mass	Belt Line Railway Co	4	4.50
Milwaukee, Wis	Milwaukee Cable Co	12	15
New Bedford, Mass	Union City St. Ry. Co	5	3
Newton, Mass	Newton Street Railway Co	10	8
Passaic, N. J	Passaic Street Railway Co	8	3
Portland, Oregon	Woodstock & Waverly Electric Co	4	5.25
Pueblo, Col	Pueblo City Ry. Co	10	21
Port Townsend, W	Port Townsend Street Railway Co	3	3
Redbank, N. J	Redbank & Seabright Railway Co	3	3
Rockford, Ill	Rockford Street Ry. Co	7	6.75
Shreveport, La	Shreveport Ry. & Lamp Imp. Co.	4	5.25
Salem, Mass	Naumkeag Street Railway Co	6	3
San Jose, Cal	San Jose & Santa Clara R. R. Co	6	9
Saratoga Springs, N.Y	Saratoga Electric Railway Co	2	2.50
Salem, Ohio	Salem City RailwayCo	3	2
So. Bend, In	So. Bend & Mishawaka St. Ry. Co	6	8
Springfield, Mass	Springfield Street Ry. Co	6	2
St. Louis, Mo	Union Depot Railway Co	30	12.50
Springfield, Ill	Springfield City Ry. Co	8	7
Toledo, O	Toledo Electric Ry. Co	25	17
Toronto, Ont	Metropolitan Street Railway Co	2	2.75
Utica, N. Y	Utica Belt Line Railway	25	20
Vancouver, B. C	Vancouver El. Ry. & Ltg. Co	4	3.50
Washington, D. C	Georgetown & Tenallytown St. Ry. Co.	6	6
Winona, Minn	Winona City Railway Co	5	4
West Superior, Wis	Douglas County Street Railway Co	2	4
	39 roads	431	385.20

COMPARISON. ROADS IN OPERATION.

	No. of motor cars.	Length of track in miles	No. of roads.
December 15th, 1889	528	335.75	49
April 1st, 1890	665	463 56	61
Increase	137	127.81	12

The grand total of roads built and under contract is 100 roads 1,096 cars and 848.76 miles of track.

The company have also received "repeat" orders as follows from roads in operation: Second Avenue Passenger Railway, Pittsburgh, 10 motors; Bangor, Me., Street Railway Co., 10 motors; Central Railway Co., Peoria, Ill., 12 motors; Des Moines, Ia., Electric Railway Co., 20 motors; Denver, Col., Tramway Co., 4 motors.

... IF I can succeed in working a magnet ten miles I can go round the globe.—*Prof. Morse.*

.... THERE is a proper curiosity in knowing the possible influences which produced a man on whose brow fame has, with much apparent fondness, rested her decorating hand.—*Hon. James D. Reid.*

.... THE electric telegraph as it exists to-day was of slow and gradual growth—so slow and gradual that it is impossible to point to any one man as being the inventor of telegraphy.—*G. W. de Tunzelmann.*

.... ELECTRICITY as a science is susceptible of great powers to stimulate and delight. Its demonstrations are, unique, startling, brilliant. No branch of experimental philosophy is so full of pictures, so replete with surprise.—*Hon. James D. Reid.*

....SINCE the use of gas has become so general in our cities as to be considered almost one of the essentials of civilized life, a new source of danger has been introduced. Persons who repudiate the use of lightning rods because they attract the electricity from the clouds, should reject the introduction of gas—particularly in the upper stories of their dwellings, since the perpendicular pipes must act as the most efficient conductors between the clouds and the earth.—*Joseph Henry.*

CORRESPONDENCE.

NEW YORK AND VICINITY.

The New Subway Work.—The Edison Exhibition.—The Edison-Gilliland Phonograph Suit.

AT the last meeting of the Board of Electrical Control, the Standard Subway Co. withdrew from the contest to obtain a share of the subway building, and the Board has now given orders to the old Consolidated Company to proceed with the work. The plans now approved cover a large number of streets and will require, it is said, about two years to be carried out.

The Edison exhibition at the Lenox Lyceum, Madison avenue and Fifty-ninth street, for the benefit of the New York Exchange for Women's Work, draws delighted audiences every afternoon and evening. The phonograph exhibition is truly wonderful. The electric lighting apparatus, the talking dolls, the telephone combinations, and a score of ingenious and wonderful things are to be seen and heard there during the whole of the present month. Over $5,000 has already been received by the lady managers, for season tickets alone.

Mr. Luther Stieringer is very much to be congratulated upon the success, immediate and pronounced, that he has won with the "Tower of Light," and which, with the help of Messrs. Seubel and Meadowcroft, he built from his original designs in one short week. It is an immense column, gracefully proportioned, in the centre of the hall, eight feet in diameter and twenty five feet high, with 3,000 to 4,000 small Edison white and colored lamps running spirally around it from the base to the capital, on which are massed a number of larger lamps in ground glass globes. The lights on the tower are operated by switches grouped within it, and are also in circuit with hundreds more on festoons of smilax carried out to the galleries, like streamers from a huge May pole. The operator in the tower throws all the lights on at once or in sections, and now and then flashes them in time with the music. The effect under any of the conditions is most beautiful, and it is understood that Mr. Stieringer proposes to try some further startling combinations of the novel and the beautiful, all to be achieved with apparatus grouped in the tower. It is a detail, but worthy of note, that all the wires within the the tower, and they are not a few, are run through "interior conduits" which lend themselves aptly to this class of work. The "Tower" has already become one of the great features of the show. A curious part of the matter is that many of the people who stand and admire it do not know that it is a product of American taste and skill but think that it "came from Paris" with the rest of the Edison exhibit and the latest spring fashions. When they learn that it is wholly an American idea, they seem surprised that such is the case, and go away gratified and patriotically pleased with the electric rival to the iron Eiffel.

Judge Wallace of the U. S. Circuit Court has handed down a decision sustaining the demurrer to the complaint in the suit of Thomas A. Edison against Ezra T. Gilliland and John C. Tomlinson. Edison alleged that he authorized Gilliland to sell his phonograph company stock; that Gilliland found a purchaser—Mr. Lippincott, of Philadelphia; that a contract was made for the sale, and that then he made a discovery. It was that Gilliland, having taken Tomlinson in with him, had agreed that Mr. Lippincott should take the stock for $500,000 and should pay $250,000 for certain agency rights to sell phonograps held by Gilliland. Gilliland, Edison charges, represented that he was to be paid for his agency rights in stock not worth over $75,000, and at the same time had an agreement with Lippincott to take the stock off his hands at par. Mr. Edison sued to recover the $250,000, which he alleged the defendants had obtained by fraud. Judge Wallace says: "The bill is fatally defective, because the facts set forth do not disclose that the plaintiff has parted with his stock or otherwise been a loser in consequence of the alleged misconduct of the defendants. He has entered into an agreement to sell and deliver his stock at a future day upon receiving the purchase money, but that day had long expired before the contract was ever consummated. For all that appears he has the stock now, is still its owner, and nothing ever came from the contract. Whether Lippincott repudiated it or whether the plaintiff did or whether it was carried out is left wholly to conjecture. It must be assumed upon demurrer that the plaintiff has stated his case as favorably as the facts will permit. It must be inferred, therefore, that the contract for some unexplained reason has fallen through and that the plaintiff is in the same position as before it was made. The case as stated by the bill is at best one in in which a principal has employed agents to sell property for him and they have taken advantage of their agency to sell their own property at a price largely in excess of its real value. The case is not one where the principal has lost the sale of his own property by the misconduct of his agents, but the theory of the bill is that the property was actually sold, while the facts alleged show that the sale has never been completed, and consequently that the plaintiff has lost nothing by the transaction."

NEW YORK, April 12, 1890.

PHILADELPHIA.

Chief Walker's Report on the Electrical Bureau.—Ferreting out Bogus Telephones.—A Suit Against the Frankford Merchants' Electric Light Company.

THE Chief of the Electrical Bureau made his annual report a few days ago. The report commends itself to consideration, as it enters into the workings of the various systems of electric lighting; telegraph and telephone and conduit companies using the streets of the city for the above purpose.

The careful supervision maintained by the Electrical Bureau of the overhead construction has a resultant effect, inasmuch as no fires and but four deaths have occurred in this city since the introduction of electric light, three of which were employees of the electric light companies and one accidental, caused by a fireman cutting a wire from the roof of a building, which, falling across the electric wires, carried their current to the street, where a boy became entangled in it with the result mentioned. The bureau has tested and has in operation an underground system for the arc light wires and for telegraph and telephone service, which has been found to work in a satisfactory manner.

D. R. Walker, chief of this Bureau, does not hesitate to endorse this system. His experience that it can be made to work in a manner that will greatly improve the service, as well as reduce the cost of maintenance materially, and at the same time remove from our streets the unsightly wires and poles.

During the past few months the American Bell Telephone Co., of Boston, has had detectives at work in this city endeavoring to ascertain how many "bogus" or outlawed telephones were in use here. Over 200 have been discovered, and last Thursday the first batch of fifteen or twenty liverymen, doctors, dentists, druggists and fuel dealers who have been using the infringing telephones were summoned to appear in the United States Circuit Court on the first Monday in May. Dr. S. M. Plush, Manager of the Bell Telephone Co. of Philadelphia, said last evening: "Those bogus telephones are doubtless the remains of the assets of some former competitors of our company. Somebody has been trying, evidently, to work off those old 'phones. Two years or more ago the American Bell Co. brought exactly the same kind of a suit against a number of business men, some of whom are on the list at this time. They were all released upon the promises that they would not continue to use the infringing instruments. Such will not be the case this time. I cannot understand how so many good business men can permit themselves to use what they know it is against the law to use. Every intelligent business man knows of Professor Bell's victory in the courts. I am astonished, so was the American Bell company's agent, at the number of illegitimate telephones that have been in use in Philadelphia during the past year or two. We meet constantly with wires not our own, and we know of course, that they are "pirates."

The Westinghouse Electric Co. recently brought suit against the Frankford Merchants' Electric Light Co., to recover $7,882.01 for a claim arising under a contract entered into between the parties, in pursuance of which the plaintiffs furnished defendants with material and labor used in the construction of an arc electric light plant in defendants' station in this city, consisting of dynamos, lamps, armature, etc., etc., and work of construction.

PHILADELPHIA, April 12, 1890.

CHICAGO.

Mr. Pumpelly before the Chicago Electric Club.—Purchase of the Winsor-Wirtz Lightning Arrester.—The National Engineering Bureau.—The Bucket Shop Fight.

ON Monday evening, the 7th inst., an able and interesting paper entitled "Storage Batteries to the Rescue," was read before the Chicago Electric Club by Mr. J. K. Pumpelly, who pointed out very clearly the occasion when the accumulator comes in as an aid to the dynamo-electric machine, and its many general features of advantage and utility. This paper called forth a lively discussion upon the commercial success of storage batteries, participated in by Messrs. Sperry, Kempt, DeLand, Black, Bauer, Degenhardt and Badt, in which the various merits and demerits of the much maligned secondary battery were pretty thoroughly commented upon.

The Westinghouse Electric Co., of Pittsburgh, have just purchased the Winsor-Wirtz lightning arrester, which it is claimed is simpler and more reliable than any at present in the market.

The National Engineering Bureau is a new enterprise, with offices located in the Rookery. Its promoters, Mr. Thos. G. Grier and Mr. Jas. A. Lounsberry, are gentlemen of known ability and extensive theoretical and practical knowledge in engineering and electrical work. The object of the bureau is to carry on a business in testing, drawing up reports and specifications, and especially carrying out inspection work.

The Board of Trade made another move this week in the fight against the bucket shops which closed up one more avenue through which they might get quotations. Commission firms which have posted quotations on blackboards in their offices for the benefit of their customers were requested by the management of the board to discontinue the practice for the present. They all acquiesced, and the result was that the bucket shops were incommoded to a greater degree than at any time since war was declared against them. They failed to get more than one out of ten of the regular quotations, and these were not posted until about five minutes after the trade was made on the floor of the board. Consequently the bucket-shop proprietors are taking a pessimistic view of the situation, while the Board of Trade people are correspondingly elated. As an instance of the decline of the bucket-shop business in outside towns, it is stated that the proprietors are canceling their orders for the commercial circulars published here, which they have always subscribed for to be distributed to their customers.

They deem it advisable to cut down all their expenses until the result of the fight is known.

CHICAGO, April 12, 1890.

BOSTON.

Resignation of Mr. S. E. Barton and Captain William Brophy.—Their New Sphere of Work.—The Electric Mutual Insurance Co.—Increase of Thomson-Houston Stock.—Edison Toy Dolls Now Ready for Sale.—Supervision of Electric Wires—Speed of Electric Cars.—Cambridge Allows Tow Cars.—Extension of the Edison System.—The West End Street Railway.—The Laminar Fibre.—The Berrenberg Vacuum Pump for Lamps.

MR. S. E. BARTON, chairman of the electric light committee of the New England Insurance Exchange, and Captain William Brophy, chief inspector of the New England Insurance Exchange, have both resigned their positions, and from the first of April have entered upon their new duties, the former as president and the latter as chief inspector of the Electric Mutual Insurance Co., with headquarters at 85 Water street, Boston. Mr. Barton has been connected with the New England Insurance Exchange since its organization in 1883 and Captain Brophy since April, 1886. Both gentlemen have been regular attenders at the electric light conventions, and are most favorably known amongst electric light men from all parts of the country. From an underwriter's point of view, their opinion of an electric light station is extremely valuable and perfect, a very short examination, the result of extensive experience, being necessary by them to determine the true character of a plant as regards fire risks. The schedule for rating electric light central stations about a year ago is too well known to require discussion, and it is interesting to note that since that schedule was adopted by the New England Insurance Exchange, in April, 1889, a very similar schedule has been adopted and partially applied by nearly all the other insurance organizations, among them being the New York State organization, the Middle States', Philadelphia, the Southern States', at New Orleans, and the Southeastern Tariff Association, at Atlanta, Ga. Messrs. Barton and Brophy's past experience has thus eminently fitted them for the sphere of work upon which they are now entering, and success is sure to crown their efforts in providing for all electric light and power companies an insurance company which will fully understand their requirements, issues policies suitable to the case and prevents them from insuring in half a dozen more companies, each one of which has conflicting suggestions to make before it will issue a policy.

The Electric Mutual Insurance Co. proposes to commence to issue policies on May 1st.

They have prepared and are about to send to all electric generating stations, a small pamphlet (the full text of which is printed on another page), setting forth the requirements for construction, equipment and maintenance of standard electric light or power stations. Already over $2,000,000 pledges have been given, that is, insurance ready to place on May 1st. The Electric Mutuals, as it is commonly called, will begin by issuing not more than $15,000 insurance on one station, but will place the balance at the same rates with eight or ten of the strongest English and American insurance companies, who have placed their agencies with the Electric Mutuals, and will accept lines varying from $5,000 to $10,000 on any station accepted by the Mutual company. All the examinations of the stations will be left entirely in the hands of the Mutual company, Captain Brophy and such assistants as he may require, performing functions with regularity and intelligence, and no cancellation of policy will be possible. Besides issuing policies on the stations, the Mutual company will also insure street circuits and lamps under separate policies, a class of insurance which has hitherto been extremely difficult to obtain from stock companies, first, because they are afraid of the supposed dangers of the current, and secondly, because they are already loaded with insurance on the buildings and their contents in every city, and have all that the insurance laws will permit them to carry. To accommodate stations at a distance, blank surveys will be sent at present, though probably inspectors will be appointed in a number of local centres as the business grows. Messrs. Barton & Brophy have the good wishes of a host of friends, who desire for them every success in their new enterprise, believing that they are acting for the distinct benefit of every holder of electric light stocks and securities in the country.

The stockholders of the Thomson-Houston Electric Co., at a special meeting held at Middletown, Conn., voted to increase the capital stock $3,000,000 making the total capital stock outstanding $11,500,000.

The Edison Toy Doll Co., have at last got their dolls perfected for the market, and have begun to deliver them in fulfillment of orders. They are now making them at the rate of 300 to 400 per day.

The mercantile committee had a hearing this week at the State house, upon several orders relative to the supervision of electric wires. E. W. Burdett appeared for the Massachusetts Electric Lighting Association, G. A. Bruce and S. L. Powers for the American Bell and New England Telephone Companies, and F. A. Wyman for the Westinghouse Electric Co. Mr. Means argued that the wires as they existed to-day were not properly guarded, and claimed that compulsory legislation was necessary for Boston, to compel companies to remove their dead wires, as the city council cannot pass such ordinances. Mr. Powers argued strongly in favor of allowing things to remain where they are, and claimed that it would be a poor policy to establish a state commission for the regulation of the wires, New York being an example of such a policy. He claimed that the electric companies were amply able to look after their own wires, and that there was no need for legislation. The hearing has been continued.

As was to be expected the slow speed of the electric cars has so annoyed the traveling public that, at a recent meeting of the board of aldermen two petitions from prominent business men of Boston, were presented asking that the standing regulations of the board of aldermen be so amended as to allow street cars to run at a rate not exceeding 12 miles an hour on Shawmut avenue, south of its junction with Tremont street. To illustrate how easily it is for complaints to be made on alleged over speed, it is amusing to read the following story copied from a daily journal: "A driver of one of our slow-going electric cars tells an experience with an old gentleman who rode in from Cambridge one day, and, becoming alarmed at the 'great speed' of the car, threatened to report the matter to the superintendent. He did so, and the driver was called up for a reprimand. 'This man complains that you ran your car at least 15 miles an hour,' said Superintendent Monks. 'What have you to say to the charge?' 'Well,' answered the driver, 'if I ran my car 15 miles an hour you must have pretty swift horses on your horse cars, for I followed one all the way from Central Square.' He went back to his car minus the reprimand."

At a recent meeting of the Cambridge board of aldermen the recent order for the withdrawal of tow cars was rescinded and the board gave the West End Co. permission to run the cars, providing that two men be placed in charge of each car, that the company reopen its South Boston line for one fare, and that fenders be placed on the cars at the earliest date possible.

THE Edison Electric Illuminating Co. has declared a quarterly dividend of one per cent., payable May 1. During the coming spring and summer they will make extensive alterations on their premises at Head place, and have commenced operations to increase their present building two stories. The present office room will be used for an extension of the dynamo room, and the office, stock rooms and meter room will be moved upstairs. Extensive increases in the underground operations are now in progress, and the Back Bay Incandescent Co., which was organized some months ago for the purpose of providing lights for the Back Bay district, has made arrangements with the Edison company to run feeders and mains there this summer, and will be heard of no more. Mr. C. L. Edgar, the general manager of the Edison Illuminating Co., returned from his European trip last week, and all the alterations will be made under his careful supervision.

At a meeting of the Society of Arts, held in the new Institute of Technology building, Professor Elihu Thomson read a very interesting paper on "Experiments with Alternating Currents," practically illustrated. It covered the ground given in THE ELECTRICAL ENGINEER'S abstract this week.

Before the Street Railway Committee, ex-Governor Long made the closing argument in favor of allowing the West End Street Railway Co. the privilege of erecting an elevated road in the more crowded parts of the city. He argued that there was a necessity for increased facilities and more rapid transit, a fact which, he said, showed beyond all doubt that the company's petition was entered in good faith. He declared that the necessity could be best met by the West End company, with the minimum of inconvenience of cost and of danger, and with the maximum of convenience, of safety and economy. The electric car will still hold the surface of the streets, whatever charters are given, and all the West End company asked for was the privilege of relieving the streets in the crowded part of the city. Following Mr. Long, came Mr. Solon Bancroft, of Reading, who made the closing argument for the People's Elevated Railway Co. (C. H. Nichols and others). He contended that it would be for the benefit of the people that there should be an independent system of elevated roads, having no connection with any existing organizations, and he claimed that there was no danger of combination with the West End or other corporation. G. H. Towle, of Boston, closed for the Meigs petitioners. He severely criticised the West End bill, and said there was no rapid transit in it. It was only a transfer to the West End company of all rights and powers of the general court over the streets of Boston and the surrounding towns. Arguments will follow for White, Bartholomew, Mac and Torrey in the order named, and the outcome is looked forward to with an immense amount of interest.

The West End Street Railway Co. have petioned the Cambridge Board of Aldermen for permission to set up and maintain boilers and engines at the old glass house in East Cambridge, which it had recently purchased for a power house, and permission to run feed wires from that building to the company's electric lines. Foundations of the new power house in Cambridge have been laid and the brick work started. The equipment of this plant will consist of 10 250-h. p. dynamos, which will furnish power to about 250 electric cars. Until the station is completed this fall, the power will be furnished by the Cambridge Electric Co.

The Laminar Fibre Goods Co. has been organized, with headquarters in the New England building, for the purpose of manufacturing an insulating material called "Laminar Fibre," which is made either in sheets or tubing, hard or flexible. Mr. C. H. Whall, the manager of the company, has been connected with the manufacture of fibre goods for several years, and Mr. T. S. Hanna, the superintendent of the factory, which is situated at North Cambridge, is the original promoter of fibre interests in this country, having been connected with its manufacture for about 14 years. Laminar fibre in sheets and in its natural color, looks and cuts like a piece of horn, and is perfectly homogeneous in its nature, and can be used for an infinite number of mechanical purposes, such as bearings for light running machinery, small pulleys, toothed noiseless gearing pump valves, etc. It will stand an immense amount of heat, and is non-inflammable, possessing also great tensile strength and resistance to compression. Though it can be made of any color for insulating purposes, Mr. Whall recommends the natural gray color, which prevents the introduction of any foreign or mineral substance to produce the coloring. It can be tapped and screwed, and machined into any shape, and there is practically no limit to the field of its uses. For pulleys it requires no bushing, laminar itself being able to outwear any steel spindle ever made. The factory is one of the finest in the country for the production of fibre goods, costing $60,000, and is fitted with the best and most modern machinery for the manufacture of laminar into any desired shape.

Several very interesting exhibitions of the Berrenberg vacuum pump, the invention of Mr. Adolph Berrenberg, of Somerville, have been given this week at 109 Purchase street. The pump is designed for exhausting incandescent lamps, instead of the present mercurial pumps now used by all lamp manufacturers. The pump is not entirely new, experiments having been made with it some years ago, but it is only within the past few months that it has attained its perfection in the hands of Mr. Berrenberg, assisted by Mr. Wm. E. Nickerson, a mechanical and chemical expert. This week, Mr. J. E. Randall, superintendent of the Thomson-Houston lamp factory, and Mr. J. R. Lovejoy, were present at some tests, and have exhausted a few lamps of their own manufacture for the purpose of future experiments. The pump, to look at, is an ordinary three-cylinder piston air pump, but the inside construction of it has not yet been made public. Lamps can be exhausted in 15 minutes by the Berrenberg pump, against five hours by any mercurial pump, and show by the mercurial tests wonderful results. The current can be put on the lamps in 30 seconds after the pump starts operation. The degree of exhaustion is very easily tested by breaking the stem of a lamp after it is sealed, under mercury, when the mercury immediately rushes into the lamp to supply the vacuum. The air left in the lamp is shown by a small globule, and the smaller the globule the better the exhaustion. It is not too much to say that the globules of air in lamps exhausted by the Berrenberg pump were as small, and in many cases smaller, than those in lamps exhausted by the small mercury pump. Tests are also being made on the life of the lamps, which are up to the present entirely satisfactory, some being shown which have burned about 600 hours, considerably over potential. The result of the investigation by the various lamp companies will be looked forward to with great interest, as the use of this machine, ought to cheapen the manufacture very considerably, since the process of exhaustion forms from 20 to 30 per cent. of the cost of manufacture. The claims made for the pump, and which appear to be well borne out by the experiments, may be briefly summed up as follows: It does in minutes what now takes hours for a mercurial pump, and the work is better and more uniform; it does also what would require hundreds of mercurial pumps; it takes up very little room, and will not poison those who work it; the lamps made by it are better than others, and will burn longer on account of the uniformly good vacuum it produces. The pump has a strong syndicate interested in its development and it will soon be put to practical use.

BOSTON, April 12, 1890.

PITTSBURGH.

Developments in Electric Railroading.—Telephonic and Railway Interference.—Damage by the late Gale.—Electricity as a Manufactured Article.

THE Duquesne Traction Co.,—the corporation, which is going to cover this whole city with a network of electric street car lines,—evidently does not intend to let grass grow under its feet. Last week work was already begun on the power-house, which is to be built on the corner of Fifth avenue and Craig street. The company proposes to have the first car running by next fall. Car loads of Belgian block are constantly arriving and everything is pushed along as rapidly as possible. The directors of the company have, however, not yet decided which system of electric motive power is to be utilized.

The Troy-Hill electric railroad company has received a charter from the Governor of Pennsylvania for the purpose of building a street car line from Allegheny city to Troy Hill. The company has a capital stock of $100,000. The line will be about three miles long and it is almost decided by the company to operate the line with the Sprague electric motor system.

Charters were also granted to the following corporations of this city: The Exchange street railway company, four hundred feet in length, capital $1,000. The Monongahela street railway company, one mile in length, capital $3,000. The Grant street railway company, one half mile long, capital $6,000. The Riverside street railway company, three-tenths of a mile in length, capital $1,800. All of these lines are intended for feeders of the Duquesne Traction Co.

The local telephone and telegraph companies are constantly expressing their undisguised displeasure at the rapid development of the electric street car systems in this city, They make the charge that the many street car wires interfere greatly with their own wires. The telephone company has been compelled to move its wires entirely off Second avenue, where an electric road is operated with the Thomson-Houston system.

The high wind, which swept like a cyclone over the eastern portion of Ohio last week made itself also felt in this city very strongly and considerable damage was done here to the electric wires. The Second avenue electric line had to cease operation for several hours, on account of one of the wires breaking on Fourth avenue.

The plan, to build an electric railway from Allegheny city to Belleview, which was started some time ago, has been abandoned, on account of the inability of the promoters to get the necessary funds for the enterprise together. A bridge would have had to be erected across Jack's Run to complete the line, and the cost of this structure seems to have frightened the promoters of the enterprise.

The Citizens, Traction Co., which is now operating a cable road from Pittsburgh to Lawrenceville, has decided to build an electric line from the present terminus to Sharpsburg a distance of two miles. The latter is now operated by horse cars.

Judges Simonton and McPherson, of Harrisburg, Pa,, recently listened to the argument of two cases for the purpose of determining whether electricity or electric light is a manufactured article. The Brush Electric Light Co., and the Philadelphia Electric Lighting Co., refused to pay the tax levied against them because they are manufacturing companies. The commonwealth, however, seems to have a different idea of the case, and has therefore asked the courts to decide the matter.

PITTSBURGH, April 11, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE PUFFER TESTS OF INCANDESCENT LAMPS.

[122.]—On page 162 of your issue for April 2, there are five tables showing the efficiencies of the lamps of various makers.

These tables are the authorized production of the Rogers' Laboratory of Physics, Massachusetts Institute of Technology, of Boston, bearing the endorsement of Professor Wm. L. Puffer.

These tables show that various lamps of well-known makers vary in efficiency expressed in terms of watts per horizontal candle power from 2.45 to 4.26 watts per candle. These tables on examination will be found worthless when it is noticed that lamps are not burned at the candle power they were made for, and at which they are ordinarily used in commercial practice.

There may have been no partisan spirit running under the tests, but the casual reader would be led to infer that the tables expressed the relative value of the lamps tested. Whereas the tables only express that lamps wrongly marked were tested at the false volts marked on them rather than at the candle power the lamps were made to burn at.

If it were not for the weight of the names attached to the paper I should consider it only a subject for passing ridicule. But bearing the stamp which should only seal valuable *and complete* work, and giving as it does wrong impressions, the paper should not pass without protest. FRANCIS R. UPTON.

HARRISON, N. J.

SOCIETY AND CLUB NEWS.

BUFFALO ELECTRICAL SOCIETY.

Madison Buell read a paper on "Rapid Transit" before the Electrical Society on April 7.

It was admitted by electrical and other people, the speaker said, that this country had made greater progress in the application of electricity to railways than all the rest of the world. On January 1, 1890, there were 151 roads in operation and under contract, with an aggregate of 1,641 miles and 2,346 cars. The street railway company of Minneapolis threw aside the half million unused cable plant, adopted the electrical system of transit, and has made a big success of it. Yet Buffalo was now going through the chrysalis stages of discussion and arguments relative to the adoption of such a system.

The same arguments, the same objections, had been gone over in nearly 200 towns and cities, and they had been met and answered decisively. The Buffalo Street Railway Co. refused to adopt, and wisely, too, the cable system, but was willing to adopt the trolley system, subject to certain conditions acceptable to the people of Niagara street. There were grave and even insuperable objections to the storage battery.

In THE ELECTRICAL ENGINEER of April 2, he said, was an illustration of the new Sprague railway underground work, and this was undoubtedly the system that the Buffalo Street Railroad Co. intended to put—or ought to put—on Niagara street. This plan, as described, contemplates carrying double trolley wires between double tracks, with the mains and feeders carried in insulated feeders underground. The sub-feeder wires between the main line and the trolley line will be carried up the interior of the poles in insulated "interior conduited" pipes. Another set of wires for lights will be supplied from a separate switching circuit running direct from the station and connected with all the series of light on the poles. The details of this system, it was claimed, give a very excellent form of construction for street railways, making the overhead system entirely unobjectionable and furnishing also the lights for the streets through which the road passes, the control of the lights being from the power station direct.

Holding it to be proved that the pressure of electricity used for the trolley system is not dangerous to life, the lecturer held that the danger to be feared was simply from the network of wires used in its present construction, and their proximity to the electric light wires. The Senate Committee on General Laws having presented to the Senate a report which recommends that all electric light wires be placed under ground, the danger constantly menacing the trolley system would be abated.

The railway people should have authority to move their tracks one foot toward the curbing of the sidewalks. This would be an item of expense which would be vigorously opposed by them, but it would have the effect of giving the citizens a new road the entire route, besides giving a wider space between the two tracks, which would not interfere with the regular traffic of the street. This extra space would be required anyway for safety, as the electrical cars run much faster than the horse cars. The courts and the legislature having taken hold of electrical matters and obviated the greater part of the dangers of electric railway traffic, it was only necessary for the Niagara street people to come to some understanding with the street railway officials and arrange the details of a system that will prove beneficial and satisfactory to both parties and a source of pride to the citizens of Buffalo.

NEW YORK ELECTRIC CLUB.

The Electric Club will hold its annual meeting for the election of officers at its club house, 17 East Twenty-second street, next Thursday evening, April 15.

.. NO PART of the writings of Franklin exhibits his sagacity and his power of sicentific generalization in a more conspicuous light than his theory of electricity. The talent to discover isolated facts in any branch of science, although possessed by a few, is comparatively inferior to that characteristic of mind which leads to the invention of an hypothesis embracing in a few simple propositions whole classes of complete phenomena.—*Joseph Henry.*

BRIGHTER PROSPECTS FOR THE U. S. PATENT OFFICE.

A SPECIAL dispatch from Washington of April 11 says: "It is a topic of common remark that the golden age of invention is at hand, if encouragement by the government counts for anything. The present Congress seems more than merely well disposed towards the patentee class. Representative Butterworth's bill appropriating three million dollars to build a new Patent Office has been favorably reported to the House, and will probably go through as even the strictest economists will not complain that the sum is exorbitant in view of the character of the building required, nor can it be argued that it is a bad business idea to give a proper housing to the one bureau of the government which brings in a handsome yearly revenue above all expenses. The money to be spent on the new home for the Patent Office bears no extravagant proportion of the amount which actually stands upon the books of the treasury to the credit of that institution.

Mr. Simonds' bill, also increasing the pay of the leading members of the Patent Office force, is regarded as having a fair prospect of success. With the host of other channels of expenditure clamoring to be filled by the present Congress, there may be some reduction of the amount to be distributed in increased salaries for the present; but Commissioner Mitchell cogently remarks: "The primary examiners are now drawing no more pay than they were in 1848, when the labors of everybody in the office were infinitely lighter, and when the competition for first-rate ability between the government and the business world outside was not nearly so sharp. It cost less to live, and the best men could afford to work for lower pay. But it is all wrong to continue nowadays the salary-list of that period. The inventors themselves have a right to demand better treatment at the hands of the government. If they are willing to pay good fees, it is only reasonable in them to expect the best service their money will buy. What is the fact? We are taking from them hundreds of thousands of dollars of their money every year; we shall turn into the treasury this year a cool $228,000 over and above all the expenses of running the office. The increased salaries proposed by Mr. Simonds would foot up about $60,000, leaving $168,000 clear profit still. Is it an extravagance to ask such an advance from Congress?"

Another consideration which will incline many person to look kindly upon Mr. Mitchell's recommendations is the fact that he has shown, thus far, a proper respect for the dignity of his own office, and for the technical character and standing of the bureau over which he presides. Though a Republican partisan of the strictest stripe, he appears to have conducted his bureau generally in accord with the spirit of civil service reform. That is a good deal to say for a bureau chief who is responsible to such a cabinet officer as secretary Noble. The result of Mr. Mitchell's business-like administration is that the work of the office is nearer abreast of the incoming business than it has been for several years, and patents are turned out faster than ever before, without any apparent neglect of the preliminary details.

THE NATIONAL FAST TELEGRAPHING TOURNAMENT.

IN accordance with the arrangements made by Mr. Fred Catlin, its promoter, the National Fast Sending Telegraphic Tournament, came off on Thursday afternoon and evening, April 10, at Hardman Hall, this city, when money prizes aggregating $820 were competed for by the largest gathering of contestants ever seen on such an occasion, and in the presence of hundreds of spectators. The contestants were divided into four classes as follows:—

Ladies' Class.—Free for all. First prize, $50; second prize, $40; third prize, $20.

Class A.—Open for all. First prize, $100; second prize, $70; third prize, $30.

Class B.—Open for all, barring those who made a record of better than 11 minutes in the contest of 1885. First prize, $85; second prize, $65; third prize, $30.

Old Timer's Class.—For those who were in the service prior to 1865. First prize, $50; second prize, $40.

Mr. A. B. Chandler offered a prize of $10 for best pen and ink copy, and $10 for clearest transmission, regardless of speed, to each of which the management added $10. The United Press offered $25, to the contestant, in each class, adjudged to have done the most finished and accurate sending in the quickest time. During the evening a telegram from J. I. Sabin, of San Francisco, received through the *Electrical Review*, added $100 to the prize fund, and a Commercial Cable dispatch from Dunfermline, Scotland to Mr. T. C. Martin, of THE ELECTRICAL ENGINEER, announced that the Hon. James D. Reid, now U. S. Consul at that port, would present a handsome Cairngorm brooch to the prize winner among the ladies. The other prizes were offered by the Western Union and Postal Telegraph-Cable Co.'s, Andrew Carnegie, Genl. Thomas T. Eckert, Thomas A. Edison, A. B. Chandler. W. P.

Phillips, The Associated Press, The United Press, the *Electrical World*, *Electrical Review*, the *Electric Age*, the *New York World*, The E. S. Greeley & Co., J. H. Bunnell & Co., Western Electric Co., the New Haven Clock Co. and E. H. Johnson.

The officers were as follows :—

JUDGES.—Walter P. Phillips, Gen'l Manager of the United Press; Thos. R. Taltavall, Editor of the *Electric Age;* Geo. H. Usher, Manager Postal Telegraph-Cable Co.; E. F. Howell, Official Tester Western Union, central office; Geo. E. Holbrook, of the *N. Y. World*. STARTER.—C. W. Price, of the *Electrical Review*. TIMER.—W. J. Johnston, of the *Electrical World*. MASTER OF CEREMONIES.—R. J. Hutchinson, Superintendent Telegraph, Stock Exchange.

In addition to the record taken by the judges, Mr. P. B. Delany volunteered to keep score with his ingenious new speed indicator, on which he is securing a patent. This instrument, placed in the local circuit, with the sounder, will indicate with absolute correctness up to a speed of 100 words per minute. One hundred thousand words may be indicated without rewinding. Thus the number of words transmitted over a wire during a day, or the amount of actual work done by an operator, may be ascertained with perfect accuracy. In competitive trials of speed the indicator will detect the omission or addition of a single dot in a trial of any length.

The second hand requires 120 impulses for a revolution, the minute hand requires 60 times that number or 7,200, while the hour hand marks 86,400 impulses for a revolution, which, computed at the rate of three impulses to a letter, and five letters to a word, makes 5,760 words.

Below are given the winning 5-minute records :

Ladies' class.	Delany ticks.	Words and characters.
1. K. B. Stephenson (W. U.)	2,436	217
2. B. M. Dennis (W. U.)	2,426	212—4
3. E. R. Vanselow (W. U.)	2,467	210—4

Special prize of $25 for best sending :

4. T. V. Freschel (W. U.)	2,397	200—5

Old Timers' class.	Delany ticks.	Words and characters.
1. A. S. Ayres, (Postal)	2,576	229—1
2. F. Catlin (W. U.)	1,986	217

Mr. Ayres also took a special prize of $25 for best sending.

There were a large number of entries in class A, but it is unnecessary to give the records of others than the leaders. The record of Pollock, who came from the Hartford office of the New York, New Haven & Hartford Railroad, far surpassed anything ever before made.

Class A.	Delany ticks.	Words and characters.
1. B. R. Pollock (N. Y., N. H. & H.)	2,785; 2,796	258; 260
2. J. W. Roloson (Postal)	2,616	248—3
3. F. L. Catlin (P. W.)	2,718	241—1
4. W. M. Gibson (U. P.)	2,730	239
5. F. J. Kihm (U. P.)		238

This showing left the judges in doubt as to the relative merit of the men for first place, and there was a second and third repetition of the test, with the result that Pollock made the amazing record of 260 words, or two more than on the first trial. The other competitors fell off a little. The first prize in this class was thereupon awarded to him ; the second to Gibson, the third to F. J. Kihm. The prize for best sending was taken by W. L. Waugh (U. P.) with 229 words, sent in 2,221 ticks.

The contestants in class B were quite numerous, and after a spirited struggle the prizes were awarded as follows :

Class B.	No. of words and characters.
1. F. L. Catlin (P. W.)	251—1
2. W. L. Waugh (U. P.)	229
3. F. English (P. W.)	225

Special prize for best sending :

4. J. P. Bradt (U. P.)	220—2

A special prize of $30 for the best sending, regardless of speed, was awarded to A. S. Ayres.

For the receiver's prize only one contestant, T. R. Taltavall of the *Electric Age*, appeared. He took Mr. Waugh's 229 words, and the judges pronounced his copy the finest high-speed writing they had ever seen.

Mr. W. B. Upperman, of the Associated Press, received the transmissions through the day and recorded them on a caligraph.

....NOTHING is so fatal to success in electrical work as apparatus erected in a manner that will just *do*. If a fault occurs, put it right at once and put it right thoroughly, not merely patching it up, thinking to put it right at some future time.—*F. C. Allsop.*

LEGAL NOTES.

DECISION OF COMMISSIONER OF PATENTS.

FORBES *vs.* THOMSON.

A decision was rendered March 26, by Commissioner Mitchell in the interference case of Forbes *vs.* Thomson. A patent was granted August 7, 1888, to Professor George Forbes, of London, for a method of measuring electricity which consisted in passing the current through a conductor traversing a closed vessel, evaporating a liquid therein by the heat generated in the conductor, and finally using the amount of evaporation or quantity of liquid condensed from vapor as a measure. On the same date Professor Forbes filed an application for a patent for an apparatus for carrying this process into effect. Professor Elihu Thomson had filed as early as October 19, 1887, an application claiming a similar apparatus, and interference proceedings were accordingly instituted which resulted in an award of priority to Thomson. As Thomson made no claim to the method, Forbes' patent claiming the method was allowed to issue as stated. After the issue of Forbes' patent, but before the issue of Thomson's, the latter filed a second application claiming the process. A second interference was instituted, but after the preliminary statements had been filed, counsel for Forbes moved to dissolve the interference, claiming that Thomson's application for the process was not properly a division of the the original application. The primary examiner granted the motion to dissolve, whereupon Thomson appealed to the commissioner. The commissioner now overrules the decision and reinstates the interference.

EDISON *vs.* THE UNITED STATES ELECTRIC LIGHTING CO.

On March 28, two motions were made by defendants before Judge Lacombe, in the case of The Edison Electric Light Co., *vs.* the United States Electric Lighting Co., in equity No. 3445, in which the Edison filament patent No. 223,898 is in litigation. The first motion was for leave to defendants to amend their answer and to set up as a defense the expiration of the Edison patent by reason of the lapsing of a later Swedish patent which the defendant claimed operated to terminate the prior Canadian patent and through that invalidated the United States patent. It was contended by the plaintiffs that the point was entirely covered by the recent decision of the Supreme Court in the case of Pohl *vs.* Anchor Brewing Co., but Judge Lacombe granted the motion in order that the facts might be in the records when the case came before the Supreme Court.

The second motion by defendants was for an order to compel the plaintiffs to furnish them with certain papers in a pending application of Mr. Edison filed in the fall of 1880, in which the defendants assert would be found statements limiting the scope of the Edison filament patent. These statements, it is claimed by the plaintiffs, have been made by persons formerly employed in the Patent Office and therefore surreptitiously obtained. Judge Lacombe denied the motion.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 8, 1890.

Alarms and Signals :—*Electric Alarm Devics for Clocks*, F. H. D. Schwarz, 425,004, *Electrical Annunciator Drop*, M. Hynes, 425,078. *Thermostat*, W. P. Singer, 425,089. *Thermostatic Coil*, D. W. Thompson, 425,114. *Burglar Alarm*, J. Moran, 425,143.

Conductors, Insulators and Conduits :—*Machine for Weaving Insulating Covering on Electrical Conductors*, C. T. Stetson, 425,036. *Pole for Electric Wires*, L. R. Greene, 425,071. *Device for Shielding and Protecting Wires*, H. E. Penney, 425,107.

Dynamos and Motors :—*Electric Rotary Pump*, E. I. Nichols, 425,106.

Galvanic Batteries :—*Electrode for Galvanic Batteries*, W. P. Kookogey, 425,135. *Process of Manufacturing Metallic Electrodes for Batteries*, F. Marx, 425,335.

Lamps and Appurtenances :—*Electric Lighting and Advertising System*. A. Douglass, 425,125.

Measurement :—*Voltmeter*, M. M. Garver, 425,068. *Ammeter*, M. M. Garver, 425,069. *Electric Meter*, M. E. Thompson, 425,269 and 425,270.

Metal Working :—*Method of Electric Welding*, C. L. Coffin, 425,164.

Miscellaneous :—*Switch-Board*, E. A. Owen, 424,995. *Electric Stop-Motion for Warping Machines*, J. E. Prest, 424,997. *System of Telpherage*, J. E. Maynadier, 425,038. *Lightning Arrester*, J. D. Bishop, 425,061.

Railways and Appliances :—*Electrically Propelled Vehicle*, R. M. Hunter, 425,076. *Electric Railway Car*, R. M. Hunter, 425,077. *Support for Electric Railway Conductors*, C. J. Kilian, 425,101. *Electric Railway Apparatus*, J. B. Odell, 425,388.

Telegraphs :—*Central Office System for Autographic Telegraphs*, J. H. Robertson, 425,086.

Telephones and Appliances :—*Graphophoning*, D. W. Brown, 424,956. *Telephone Toll-Box and Connection Register*, C. E. McCluer, 424,993. *Telephone Toll-Box*, H. L. Cassard, 425,161.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

A MAGNETIC PEN-HOLDER.

Various electrical devices have been invented for the prevention of what is known as writer's cramp, but if we are to credit the contents of a patent recently issued to Mr. Edwin A. Hill, the application of magnetism alone is sufficient to effect a cure. The inventors claim to have found that "by the use of a magnetic pen-holder, owing to the action of the magnetic currents from the poles of the magnet or magnets forming the pen-holder on the muscles of the hand which holds it, the user cannot experience writer's cramp to any appreciable extent."

THE FRINK SYSTEM OF REFLECTORS.

THE arrangement of the electric lights that the executive committee of the Metropolitan Museum of Art, New York, has determined to place throughout the entire building has caused the committeemen a great deal of bother and worry. There were different opinions as to the best arrangement of lights for the galleries of paintings The question was settled by having the electricians arrange lights according to different methods in different rooms for inspection. At the meeting of the full committee, I. P. Frink's system of reflectors was unanimously adopted. With these reflectors the paintings will be evenly covered with a light without glare, and throwing the interior of the room into the shade. Now that this is decided upon the work of lighting every gallery in the museum is being rapidly pushed by Mr. Frink, and very soon the museum will be thrown open on Tuesday and Friday nights for the accommodation of the public.

NEW WESTINGHOUSE WORK.

The Westinghouse Electric Co. has been awarded the contract for installing a new central station plant for electric lighting in Portland, Va., with alternating current apparatus. The plant will be started with a capacity of 1,500 lights.

The Monongahela Mining Co. is about to light one of its mines by electricity. The plant is to be of a special character so as to make it perfectly safe and economical. A current pressure of 300 volts will be utilized on the line and the lamps will be placed in series of three throughout the mine. The capacity of the plant is 150 lights and The Westinghouse Electric Co. has the contract for furnishing the apparatus.

The new Westinghouse arc lighting system is to aid in dispelling the nightly darkness at Troy, N. Y., in the near future. The Westinghouse Electric Co. has received an order from that place for a 60-light machine.

Salt Lake City is to have a lighting plant to use the Westinghouse alternating current incandescent system. The initial capacity of the plant will be 500 lights only, but the prospects are good for an increase at an early date after getting the apparatus at work.

APPROVAL OF THE INTERIOR CONDUIT SYSTEM.

It will be remembered that in THE ELECTRICAL ENGINEER of April 2, was published an illustration of the underground system developed by the Interior Conduit and Insulation Co., of 16 and 18 Broad Street, this city. That system has now been adopted for Detroit and will be put in there by the the Detroit Electric Light and Power Co., to carry services of all classes and potentials.

With regard to the "interior" system proper, the company has received from Mr. Frank Kitton, insurance inspector of the city of Buffalo and chief operator of the Western Union Co. there, the following letter:—

"Replying to your favor of March 29, 1890, asking my opinion of the utility of your system of electric wiring, I am glad to be able to say I regard it as one of the greatest advances made in this direction, since electric lighting became a commercial possibility.

"The use of your conduit tube provides great immunity from the dangers that may arise through the development of excessive heat in conductors of electricity, protects the wires from mechanical injury and excludes moisture.

"The system is so flexible, and possesses such engineering advantages as to commend its adoption to those seeking a systematic method of providing for the wiring of buildings in the course of construction, as well as others, more especially concerned in the safety of electric light and power installations."

This is, however, but one of the testimonials held by the company from prominent men in the insurance and electric lighting fields.

THE STATE OF THE COPPER MARKET.

"The strength of copper stocks," says the *News Bureau* "is based on the improvement in the metal. Mr. Lewisohn, now in Boston, says that all the leading mines are sold ahead, some up to July 1. The smaller mines have no surplus, and find no difficulty in selling their daily production. Within the past nine months the bankers holding the foreign surplus, the legacy of the old French syndicate, have marketed 15,000,000 pounds of Lake ingot, besides over 1,000,000 pounds of Arizona. Recently the bankers have sold 6,000,000 pounds ingot from 14 to 14½, with the last sale at ¼c. This has all gone into consumption, together with the production of the mines. But for this surplus copper would have sold very high. The holding of the bankers is now estimated at about 12,000,000 pounds, and they could get 14 cents for all of it to-day. The great copper demand is for wire bars and cakes, and of these brands the bankers have none. The Calumet is working day and night smelting wire bars, and the same is true of some of the Bigelow group. Wire bars and cakes are strong at 14½c. If the demand for brass and electrical purposes continues as it has the past nine months all the surplus stock will be wiped out. The consumption to-day is greater than the production. Mr. Lewisohn says, however, that he would be glad to see copper stay where it is, as the more stable the prices the better for the copper interests."

CHANGES IN THE CANADIAN TARIFF.

By changes just made in the Canadian tariff, taking effect at once, the duties are advanced on a number of electrical goods and supplies. Brass and copper wire, bare, will now be taxed 15 per cent.; they were formerly on the free list. Wire covered with cotton, linen, silk or other material, 35 per cent. ad valorem; it was formerly 25. Telephones and telegraph instruments, telegraph, telephone and electric light cables, electric and galvanic batteries, electric motors and apparatus for electric lights, including incandescent light globes, and insulators of all kinds, not elsewhere specified, 35 per cent. ad valorem; the rate was formerly 25.

It is expected that this change will stimulate electrical manufacturing in the Dominion.

"KERITE" WIRES AND CABLES.

Mr. Geo. B. Prescott, Jr., who is so well-known throughout the country as an electrical engineer of high attainments and wide experience, has been appointed general agent for Day's "Kerite" wires and cables, and will carry on the business at the old headquarters, 16 Dey street. Mr. Brixey will continue in charge of the large factory at Seymour, Conn. It is needless to say that in such hands these specialties will lose none of their excellence or popularity. Mr. Prescott assumes his new duties on the 15th, with the hearty good wishes of a very large circle of personal and professional friends.

A NEW SPRAGUE ROAD IN THE SOUTH.

We understand that a northern syndicate has secured control of the electric interests in the towns of Winston and Salem in North Carolina, and that an electric line, connecting the two towns will soon be installed. The line will be five miles long, and will include six cars. The Sprague system of overhead wiring will be used. The dynamos will be located in the electric light station which will hereafter supply both light and power for the street cars and for general industries along the line. This is probably the first station in the country, from which will be distributed electric power for street railway, and general industries, and light by both arc lamps and incandescent. Among the incorporators of the company mentioned, are E. H. Johnson, J. H. Mc Clement, F. J. Sprague and E. B. Hawkes.

Although electric roads are now in operation pretty generally throughout the northern and western states, the use of electricity as a method of propelling cars, has not as yet met with such wide adoption among the cities of the southern states, though it had there its first important introduction.

There are, it is true, a number of cities in the south where there are electric roads in operation, or in process of construction, but the horse and mule are still relied upon in most cities for the operation of the street cars. Northern capital, however, is rapidly developing many of the southern towns, and a few years changes a locality from a condition of inertness to one of business and enterprise.

Salem-Winston is a good example of the progressive towns of the new south, and shows by its interest in electrical enterprises, that it is fully awake to the latest of modern improvements.

THE NATIONAL ELECTRICAL MANUFACTURING COMPANY.

A company as above named succeeds to the business of the electrical department of the New Haven Clock Co., of 29 Murray street, and on May 1 it will remove to 14 and 16 Vesey street. This new departure is one of unusual importance. The new company, which has incorporated under the laws of New Jersey, has among those interested in it several of the most prominent and influential men in New York city. The management of the business will remain as before in the efficient hands of Mr. Noyes. The company takes over from the New Haven Clock Co. all the machinery and tools, patents, etc. that have been used by it, and will add a variety of labor saving machinery, besides being at liberty to employ at any time any of the clock making plant that may be temporarily or specially desirable.

It is the intention of the new company to make all grades of insulated wire, and they state that their facilities in this department will be equal to those of any other wire concern in the field. They will be in full operation by May 15, and will be ready to fill orders of the largest size.

It is a happy augury that at the moment of making this change, the company should have seen their New Haven Clock Co.'s telegraph key used by the winner, Mr. Pollock, last week, in the National Fast Telegraphing Tournament. This key was used by several of the speediest contestants, and with it Mr. Pollock made the phenomenal record of 260 words in 5 minutes. A peculiarity of the key is that it has no steel lever; and it is claimed that it is very superior in maintaining its elasticity.

THE BUCKEYE ENGINE CO.

The many friends and customers of the Buckeye Engine Co., Salem, Ohio, will be glad to learn that the item in the newspaper telegraphic news a few days since to the effect that their factory had been seriously injured by the recent cyclone is not true. The path of the cyclone was narrow and lay very near the Buckeye works, but that company fortunately escaped uninjured.

THE STANDARD UNDERGROUND CABLE CO.

After the first of May the New York office of this company will be found in the *Times* building, where more extensive quarters have been secured. During the past few years the enormous increase in the business of this company has made it necessary to twice double the capacity of its factories, but the present factories are still insufficient and the company has just broken ground at Brinton, Pa., for new factories which, it is claimed, will be, when completed, the most extensive wire and cable factories in existence.

THE SOUTHWARK, LONDON, UNDERGROUND ELECTRIC RAILWAY.

On March 5, the lord mayor of London, inagurated the Southwark electric railway which operates underground, including a tunnel under the Thames. The line has a double track, and current is led to the motor through an insulated conductor placed close to one of the rails, the return being through the rails and ground. There will be six stations for the completed line which extends from King William street to Stockwell, and a bill is now before Parliament for an extension of the line to Clapham.

THE FOREST CITY ELECTRIC WORKS.

Since the first of the present month the Forest City Electric Works, of Cleveland, W. B. Cleveland, manager, etc., have removed their factory to Geneva, O., where largely increased facilities will enable them to increase their outfit and keep up with orders.

....As a parting word to electric bell fitters and all who have anything to do with electric bells, I say, "Be thorough!"—*F. C. Allsop.*

.... If electricity is in reality a fluid, it might exhibit weight, could it be so isolated and condensed as to become sensible to our balances.—*Joseph Henry.*

....To protect the wires from mischievously disposed persons, let the two tubes be buried six feet below the surface of the middle of the high roads, and let each tube take a different route to arrive at the same place.—*Sir Francis Ronalds.*

.... An electrical engineer requires to know not only whether a current will be produced under certain circumstances, but also the exact effect of each one of these circumstances, so that he may be able to determine the conditions most favorable to its economical production, and design his apparatus and system accordingly.—*G. W. de Tunzelmann.*

THE CENTRAL AND SOUTH AMERICAN TELEGRAPH CO.

The Central and South American Telegraph Co. has just paid (April 8) a dividend of 1¾ per cent. The Mexican Telegraph Co. has declared a dividend of 2½ per cent., payable April 15 to stock of April 8. President James A. Scrymser of the Mexican company says the encouraging receipts of the present quarter (to March 31, 1890) tend to confirm the estimate that the business of 1890 will pay the usual 10 per cent. dividend on the new capital, $2,000,000, and leave a surplus equal to that of 1889. There are now in the treasury 874 shares of the company's stock and 1,634 shares of the Central and South American company. The balance sheet of the American company December 31, 1889, shows:

ASSETS.

Cost of Plant	$1,434,420
Duplicate cable, equipment, etc	395,034
Cash in bank	38,245
Bonds at cost	26,806
Stock at cost	127,450
Treasury stock at par	65,600
Open accounts	111,099
Total	$2,198,659

LIABILITIES.

Capital stock	$1,500,000
Invested revenue	110,913
Premium on treasury stock	16,560
Loan to C. and S. American Telegraph Co	40,000
Open accounts	95,962
Net revenue to December 31, 1889	435,223
Total	$2,198,659

Mr. Scrymser says of the Central and South American company that this quarter's receipts justify expectation of 7 per cent. on the increased capital of $4,808,000, and as large a surplus as that of 1889. There are now in the treasury 1,920 shares of capital stock. The repair steamer, "Relay," has been accepted from the contractors. The balance sheet of December 31, 1889, shows:

ASSETS.

Cost of plant	$4,351,603
Improvements	181,040
Cash in bank	230,833
Bills receivable	11,284
Investment securities	57,861
Temporary loan	40,000
Treasury stock	993,400
Open accounts	256,088
Total	$6,072,109

LIABILITIES.

Capital stock	$5,000,000
Invested revenue	476,043
Open accounts	11,538
Net revenue to December 31, 1889	584,528
Total	$6,072,109

THE McCREARY ELECTRICAL SPECIALTY COMPANY.

Mr. A. A. McCreary, of 18 and 20 Cortlandt street, whose well-known reflector for incandescent lamps has achieved such remarkable success, has been busy organizing the McCreary Electrical Specialty Co. which will carry on the industry he has built up in so short a space of time. One of the novelties it will bring out is a new patent switch for both arc and incandescent lighting, its feature of merit being the prevention of the arc that usually follows the opening of a switch.

With regard to the reflectors, it is worthy of mention that 500 of them have just been placed in the famous Corcoran art gallery, and are much admired by the Washingtonians. All the large companies are recommending the reflector and some orders from January yet remain unfilled. Mr. McCreary proposes to be up to date, however, in a few weeks.

MORE "COMBINATION" TALK.

The Boston *Herald* of April 11, publishes a remarkable special dispatch dated from Haverhill, April 10, in which it is stated a Villard syndicate is to take up some 120,000 additional shares of Thomson-Houston stock to be issued by the directors, and that this with other stock pledged to the scheme, will give the syndicate in question the majority control for which it has been seeking very anxiously. The dispatch thus concludes: "If this deal be consummated it will be one of the largest on record, and the question naturally occurs, What will become of the minority of stockholders? Will they be compelled to sell their holdings to the New York syndicate willy nilly, and, if so, at what price?"

The Clark Automatic Safety Device.—This ingenious arrangement has been designed by Mr. E. P. Clark, of the Clark Electric Co., for the purpose of avoiding the danger due to broken electric light circuits falling on metallic roofs or to the ground, where they are liable to come in contact with persons. By the Clark device, the instant the circuit parts, the dynamo is de-energized and current ceases. The action is so prompt that the opening of the line for even a fraction of a second stops the current. The automatic device has been arranged for series and shunt machines and continuous and alternating currents.

NEW ENGLAND TRADE NOTES.

MESSRS. S. C. NIGHTINGALE & CHILDS, the New England agents for the Magnesia sectional steam pipe and boiler covering, have received a contract to cover the main steam pipes, connecting pipes, drips, engine receivers, and feed-water heaters in the temporary power station of the West End Street Railway Co., Boston.

MR. F. E. PETTINGELL, of Pettingell, Andrews Co., of Boston, has returned from his trip to London, and brings with him a few English electric novelties. Though his trip at this time was ostensibly for the benefit of his health, it is satisfactory to learn that it was also profitable, Mr. Pettingell having arranged some important business while on the other side.

THE NATIONAL TELEPHONE MANUFACTURING CO., of Boston, have got out a very complete and interesting illustrated price list of their non-electric telephone apparatus. Their business in these telephones continues to increase rapidly, as they become better known. There is an extremely large field for such instruments, but at the same time there have been many failures of other acoustic telephones, and there is a certain lack of confidence in the minds of the public, which it is gratifying to know is gradually being overcome. The National company have several patents on their apparatus, and are well equipped to do excellent work, and to give satisfaction to intending purchasers.

THE TRIPP MANUFACTURING CO., of Boston, are at present engaged in building a double truck car for the West End Street Railway Co., of Boston. The car will have eight wheels, will be 28 feet long from door to door, 7 feet 3 inches wide, and 7 feet 9 inches in height from the floor, and will have seating capacity for 40 passengers. Each truck has four 30-inch steel wheels, and two 15 h. p. Thomson-Houston motors. The car will be provided with vacuum and hand brakes, and the brakes will be operated by a toggle joint arrangement, giving immense power. The Tripp patent roller bearings will be used throughout, and the car will be hung on trucks of an entirely new design, (on which patents are pending) the equalizing bar being connected direct to the journal boxes underneath, instead of passing around on top as hitherto. There are less parts and fewer bolts about the new Tripp truck than on any other form of truck, and they leave plenty of room for the application of the motors and electrical apparatus.

THE GETHINS ELECTRIC MANUFACTURING CO. are rapidly beginning to reap the benefit of their long experiments carried out by Mr. Gethins on batteries, and are coming to the front as one of the most important producers of reliable gravity batteries. The Gethins battery has been often and well described, and is now familiar to all consumers of gravity batteries, as reliable, cheap and durable. It requires almost no attention, no renewal of chemicals, and is absolutely constant, it being impossible to copperize the porous pot. The Gethins Manufacturing Co. are recently in receipt of large orders from the cities of Worcester, Pittsfield, Fitchburg, Portland, Ore., and Chelsea, the last named city having ordered for the second time, and reports go to confirm all the company claim for it.

THE TROPICAL AMERICAN TELEPHONE CO. report that the switchboard capacity at Caracas, Venezuela, is now full, and that business is growing with them in that country more rapidly than ever. The government have notified the American Telephone Co., Consolidated, a company which tried to usurp the rights of the Tropical company in Caracas, that their concession has been cancelled for non-performance of its conditions, no work having been done. Their shares are now offered at 3 per cent. of their face value with no buyers. The Tropical Telephone Co. has made an *exclusive* contract with William R. Grace and Company of New York, for Peru West Coast, under the recent Grace-Donoughmore concession by the Peru government. Mr. O. E. Madden, is at present in London negotiating the sale of the West Coast Telephone Co.'s business, and Mr. Charles Williams, Jr., is spending a few months with his family in Berlin.

THE WRIGHT ELECTRICAL ENGINEERING CO., of Boston, have contracted for the construction of a pole line of incandescent mains for the new Brush alternator recently supplied to the Haverhill, Mass., Electric Light Co. The line will extend from the central station to the centre of the city. They will also place the converters. The Wright company are also preparing plans and specifications for a 300 h. p. central station for the North Adams Gas Light Co. Provision will be made for at present three 45-light 1200 c. p. Thomson-Houston arc dynamos; and one 500-light Thomson-Houston alternating dynamo. The specifications will include two 150 h. p. Hazleton upright boilers, two 150 h. p. Fitchburg compound condensing engines, and Hunter clutches, pulleys and shafting. The Wright company have just finished wiring for 50 lights, using the "interior conduit" system, the house of Mr. W. A. Stiles, at Newburyport, a gentleman well known in electrical circles.

WESTERN TRADE NOTES.

THE KNAPP ELECTRICAL WORKS, 54 Franklin street, Chicago, are very busy filling orders for the well-known Grimshaw white core wires, tape and other specialties. They are also supplying large numbers of Perkins lamps for which they are special Western agents. These lamps have given good satisfaction wherever used, and show a remarkably long life and do not blacken.

MR. W. J. FLOYD, formerly of Boston, and well-known in electrical circles there has accepted a position with the Excelsior Electric Co. of this city and will take charge of the sales department. The Excelsior company and Mr. Floyd are both to be congratulated in this connection.

THE SPERRY ELECTRIC CO. are remarkably busy shipping their well-known dynamos to various parts of the country. The Sperry arc lamp is continuously in large demand. Mr. J. L. Kirland has joined the forces of the Sperry Electric Co. as electrical engineer, and his abilities will find there a large field.

COLONEL J. H. SHAY of the Charles Munson Belting Co., this city, has recently returned from a western trip with his pockets full of orders for their famous belting. Amongst others the following may be noted:—Denver Electric Illuminating Co., 100 feet 10 inch dynamo belting. Manitou Electric Light Co., Manitou, Col., 80 feet 10 inch dynamo belting. Pueblo Gas and Electric Light Co., 50 feet of 8 inch dynamo belting, South Denver Cable Co., 65 feet of 12 inch dynamo belting and the Kansas Ciiy Packing Co., 100 feet 30 inch double link, 272 feet 22 inch and 100 feet 20 inch double eagle. Truly Munson belting has found favor in the eyes of the electrical fraternity.

MR. GEO. FAIRBANKS, manager of the Chicago office of the Westinghouse Electric Co., is as usual busy looking after the interests and extensive sales of the company. He reports business to be in fine shape and prospects for the future very bright.

MR. W. A. SHELDON, general agent of the Schuyler Electric Co. was in town this week and called at the Electric Club.

MEETING OF THE EXECUTIVE COMMITTEE OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The above meeting was called together at 11 o'clock A. M., at the Electric Club, New York, April 14, the following members being present: Mr. C. R. Huntley, Mr. Jas. English, Dr. A. F. Mason, Mr. M. J. Francisco, Mr. John A. Seely, Mr. Marsden J. Perry, Allan V. Garratt, secretary.

A letter was received from Mr. M. D. Law tendering his resignation, owing to removal to Denver. Mr. Law's resignation was accepted, and Mr. C. H. Wilmerding, of the Chicago Arc Light and Power Co., was elected in his place.

A communication was read from the Hon. Robert R. Porter, superintendent of the U. S. Census Bureau, thanking the Association for its hearty co-operation in the matter of electrical statistics.

Mr. R. W. Ryan was appointed official stenographer for the next convention.

In view of the fact that the present quarters of the Association will be required for other purposes on the 1st of May, a committee was appointed consisting of John A. Seely, James English and the secretary, to provide new headquarters for the Association.

The question of the legal rights of the Association to use an official seal, was referred to a committee of one, consisting of Secretary Garratt.

An entertainment committee of the five following members: F. T. Walton, A. J. DeCamp, J. J. Burleigh, John A. Seely, the Secretary, was appointed, with powers to add to their own number; to appoint sub-committees and to fix the date of the semi-annual meeting.

A committee of the following three members was appointed, to procure suitable papers for the next convention: J. E. Lockwood, of Detroit, C. H. Wilmerding, of Chicago, A. F. Mason, of Boston.

It was resolved that the secretary, under the advice and consent of the president, be empowered to contract for the placing of such advertisements as he can procure, to be published in connection with the report of the official proceedings, and that the price of the proceedings be made $1 for all applicants.

Secretary and Treasurer Allan V. Garratt tendered his resignation, to take place on the 15th day of June, 1890. Mr. Garratt's resignation was accepted.

The president nominated as secretary and treasurer, to take effect upon June 15th, 1890, Mr. Allen R. Foote, of Washington, D. C. Mr. Foote's nomination was ratified by the executive committee.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

Geo. M. Phelps, President. F. R. Colvin, Treas. and Business Manager.
Edited by
T. Commerford Martin and Joseph Wetzler.

New England Editor and Manager, A. C. Shaw, Room 70—620 Atlantic Avenue. Boston, Mass.
Western Manager, W. F. Collins, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada, - - - - - - - per annum,	$3.00
Four or more Copies, in Clubs (each) - - - "	2.50
Great Britain and other Foreign Countries within the Postal Union "	4.00
Single Copies, - - - - - - - - - - - - -	.10

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* The Electrical Engineer. *Communications for the attention of the editors should be addressed,* Editor of The Electrical Engineer, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

Vol. IX. NEW YORK, APRIL 23, 1890. No. 108

Nature is our kindest friend and best critic in experimental science, if we only allow her intimations to fall unbiased on our minds.—Faraday.

ELECTRIC RAILWAY EVOLUTION.

THE remarkable energy which has lately been concentrated upon the technical and commercial development of the electric railway has allowed but little time, if any, for the consideration of problems in which the future is involved. But the changes which have been brought about even during the past few years are, it would seem, but an indication of what may be expected to take place as time passes, and as both the designer, the electrician and the railway manager avail themselves of the experience of the near past. In considering the electric railway from the standpoint of the future, in a paper read before the Boston Electric Club, the author points out a variety of directions in which advances may with certainty be looked for, not only in details of apparatus, but also in general design and methods of operation. Among these the return to the single motor instead of the pair as now employed seems probable, and desirable, from more than one consideration, while the reduction of speed and a consequent elimination of a part of the gearing is also foreshadowed. Another important point touched upon is the application of the original electric locomotive drawing two or more cars, instead of the present car with its individual equipment of motive power. That the changes suggested under this head are by no means distant, was shown by the discussion on Mr. Wetzler's paper, in which Mr. F. H. Monks, general manager of the West End Railway, announced that his company were even now at work on the designing of an electric locomotive, in order to avoid the necessity of equipping a large number of cars which must necessarily lie idle during a considerable part of the time. Such changes as these are, of course, to be looked for more particularly in large electric car installations, but that their consideration is even now in order is evident.

ARC LIGHT MACHINERY.

THE production and exhibition of the first modern arc light system set to work immediately a host of inventors, whose entire energy was bent towards devising numberless ways of generating a constant electric current, and maintaining a steady arc. The results of this work early became apparent in the rapid progress of the art in a comparatively short time, and fortunately so, for the incandescent light, which soon after entered the field of practice, so absorbed the attention of electricians in turn that the arc machine has generally been neglected for some time past, so far as any systematic attempt at improvement or modification is concerned. Signs are not wanting, however, to indicate that a revival of interest in this direction may be looked for, and, in corroboration of this we need only point to the new Hochhausen arc light machine described elsewhere in our columns. The working out of the details of arc light machines involve considerations which are not present in the designing of incandescent machines, and which make the problem a somewhat more difficult one. As a consequence of these fundamental considerations, it is also impossible to attain the economy of material ordinarily reached in incandescent machines for a like electrical output in electrical horse-power. The new Hochhausen machine, however, compares most favorably with the latter in this respect. The details of its highly ingenious construction and regulation show that arc lighting, in skillful hands, is by no means incapable of important modification or improvement; and that even with the demands in other departments, time can be profitably spent on one of the earliest.

IS POLLOCK A BEAU IDEAL?

"THE highest ambition of a first-class Morse operator" once remarked Jack Selden of the old "House" telegraph line, "is to send stuff so that nobody can read it." It would perhaps be hardly fair to say that it was this sort of sending that carried off the highest prize in the recent telegraphic manipulative competition, but it is certain that the award was not made for excellence in the qualifications most essential in a commercial operator. Telegraphy is not a purely æsthetic pastime, like horse-trotting and billiard playing, inasmuch as the question of utility must receive some little consideration. The modern tendency in telegraphy, as in other industrial arts, is to sacrifice everything to speed and cheapness, but it is one which ought to be resisted rather than encouraged. The skill which has been acquired by the modern expert sound-reading operator has led to certain material modifications in the formation of the telegraphic characters, which are not only admissible but advantageous, if not carried too far. But old-fashioned "plain Morse" will never be without its uses, so long as paper tape-readers, and partly developed sound readers must necessarily constitute a large proportion of the aggregate number of persons engaged in the telegraphic service. It would seem, therefore, as if it would be wise, in formulating the conditions for these contests of skill, to see to it that legibility of transmission, and not speed, should be the *first* point to be considered, not only in certain classes of entries, but in all.

In this connection, we may call attention to the very bright and witty article that is contributed to our columns this week, by the well-known inventor, Mr. P. B. Delany, who, having behind him no mean record as a telegrapher, discusses the tournament in all its bearings, as a connoisseur, and brings out a number of new ideas. We believe that his views of the results obtained will commend themselves in the main, not only to the operators and the telegraph officials, but to those who like himself, have graduated from the key and can discuss the situation with the kindliest impartiality to all concerned. It will be observed, by the way, that Mr. Delany's careful analysis of the figures is highly complimentary to the skill of the ladies in the contest. Their beautiful sending was unquestionably one of the most encouraging features of the occasion.

Air as Insulation.

BEFORE the advent of the electric light the large majority of electricians were engaged in the telegraph or cable service, and hence it comes that the patent records of the time referred to contain many references to forms of insulation composed of a large variety of substances, but few of which are practically applied to-day. The insulation *par excellence*, dry air, was, of course, the standard which it was desired to approach as nearly as possible, but the nature of the materials employed evidently fell far short of this, and the use of air itself as the dielectric seemed impossible of accomplishment. The advent of the telephone and the frequent enforced burial of the conductors made it still more desirable to retain the air insulation of the overhead conductors, and constant efforts have been made to reduce the specific inductive capacity of the insulating materials surrounding such conductors. As an interesting approximation to air insulation for wires in the form of cable, we presented last week a description of the method employed by Mr. John A. Barrett. Although more especially designed for telephone work, this new type of insulation seems well adapted to other electrical service involving heavy currents, and we are not surprised to find that our note on the subject is attracting attention.

A New Electric Railway Enterprise.

THE appearance of the Westinghouse Company in the electric railway field is now definitely announced, and it is understood that work will be begun immediately. This is important news, and means greater activity than ever in this vast and extending department of electrical application. There will be considerable interest as to the form of apparatus adopted by the company. Rumors have been afloat for some time that it would introduce alternating current apparatus, but it may be opined that such will hardly be the case just for the present. As to direct current machinery, it will be open to the company either to produce original apparatus of its own, or to give new life and vigor to some system already known to the public. It may do both things, but whatever it does will be watched with the keenest interest on both sides of the Atlantic. One point is clear, and that is that 1890 will be a great year for electric street railroading in America. It will require 1891 to catch up to all the work developed, and in 1892 will begin the attack on the shorter steam railroads of the country.

Possibilities of the Telephone.

THOUGH the telephone has long since ceased to be a wonder, its great powers and adaptability to various purposes as yet but hinted at, must still command attention, very much on account of their commercial aspect. This is evident on contemplating the work done by this instrument in the installation at the Lenox Lyceum, by which the "Long Distance" telephone company has placed before the public an exhibit of superb qualities. It seems strange, indeed, that up to the present time, the telephone companies have not done more towards exploiting a field which could certainly be made a source of considerable revenue by the furnishing of musical and other entertainments by wire at the fireside. But still more impressive than the musical part is the remarkable clearness of the long distance transmission. Although we are all accustomed to ordinary local telephone transmission, the mind can yet hardly grasp the reality of the enormous progress which permits persons hundreds of miles apart to maintain perfect oral intercourse. Yet, we believe the time is not remote when even this will cease to attract even passing notice, and when the "long distance" lines, now mostly confined to the Eastern States, will cover the entire country with a vast net-work of "speaking-wires." The "Long Distance" company is to be commended for the liberal policy adopted by it, in educating the public to the proper appreciation of the facilities available for it, and, if we are not mistaken, it will date one of its quickest and longest strides forward from the display at the Lenox.

Electric Tube vs. Gas Pipe.

OUR New England representative makes note in his correspondence this week of the remarkable and interesting fact that the fine new telephone building in Boston, will not contain an inch of gas-pipe, and that in its place will be found the well-known "interior conduits," through which every wire, no matter for what service, will be drawn. It is true that there are buildings in this country already where no gas pipes are to be found, but we believe this is the first instance in which the electric tube has driven the gas pipe into exile. The incident is evidently one quite out of the common, and it will be interesting to see how quickly the practice thus inaugurated becomes common. The day of the "interior conduit" is certainly upon us.

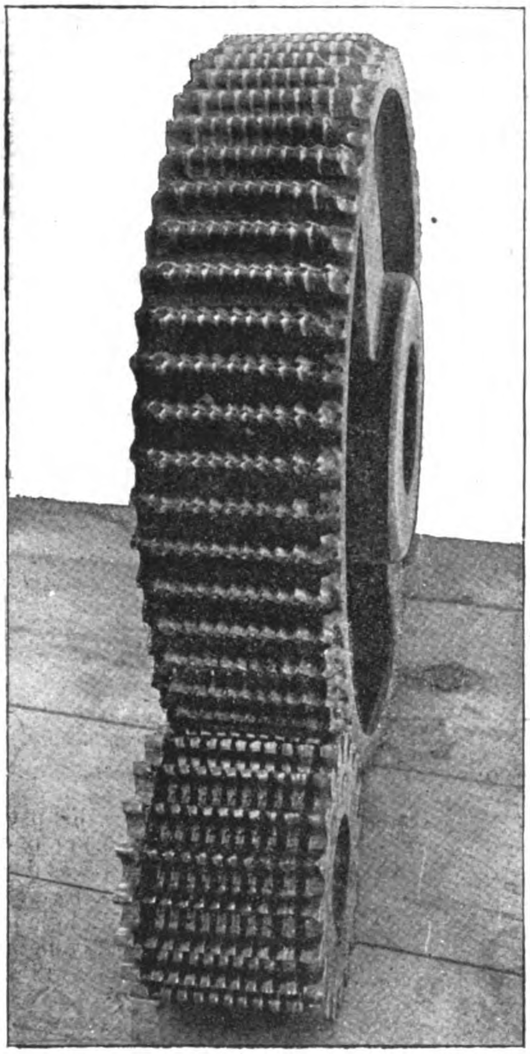
Sources of Rubber Supply.

THE statement is made by cable dispatch from Brindisi that on landing at that port and being interviewed, Mr. Stanley, the African explorer, divulged the important fact, which he had intended to mention solely in his forthcoming book, and that was that the Aruwimi forest, which belongs to the Congo Free State, was enormously richer in everything, especially in rubber trees, than the Amazon forests. This section of Africa, he declared, would be the rubber reservoir of the universe. In view of the extent to which rubber now enters into electrical manufactures, this news is encouraging as indicative of steady supply at moderate prices.

ELECTRIC CAR GEARING.

The gearing connecting the electric motor to the axles of the car has perhaps received as much attention as, if not more than, any single detail of electric railroading; and of the many devices contemplated and tried, the gear and pinion is the one most generally employed at the present time.

The ordinary practice is to transmit the power from the armature to the axle by four gears and pinions. The average car wheel and axle make about 115 revolutions per minute, to accomplish a car speed of 10 miles an hour. The intermediate shaft makes from 300 to 400 revolutions per minute, and the armature shaft from 900 to 1,200 revolutions per minute. This high speed means a rapid meshing of the teeth of the small pinions with the teeth of the gears.



Past experience, however, has shown that solid metal pinions meshing with solid metal gears produce a continuous metallic ring, increasing in volume with increase of speed; and to avoid this inconvenience, a composite pinion made of alternate layers of hard metal and rawhide, fibre or other non-resonant material, securely bound together, has been substituted very largely for the solid pinion. The disagreeable noise or hum was almost entirely eliminated, it is true, but another difficulty was developed in its place, which is vividly demonstrated in the accompanying engraving made from a photograph of a pair of electric car gears. The rapidly revolving metal parts of each tooth of the composite pinions, it will be noted, wear grooves into the faces of the teeth of the all-metal gears. Side play of the armature or intermediate shafts in some measure reduces the groove wear. The rapidly revolving small pinion, however, should wear away first; but in actual practice when the surface of the teeth of the all-metal gear is badly worn, a new gear must be substituted at the same time when the composite pinion is replaced. Solid pinions of metals other than iron are largely used to-day; they wear away more rapidly, and have the objectionable ring or hum, but, commercially, are considered of advantage. Among these, gun metal is preferably used, as also various compositions of a bronze nature. Solid steel pinions, with holes bored in the line of the axis and filled with lead, are also employed, the lead plugs being securely rivetted in position, so that they may not fall out when they become loosened after considerable service. This loosening takes place because of the peculiar compressibility of lead.

Solid fibre, specially prepared, is also found serviceable, but undue or excessive strains on worn, and even new, teeth have resulted in the breaking away of some teeth and the destruction of the pinion. Even pinions of layers of rawhide, compressed and glued together by adhesive compounds, are in service on some motor cars. Fibrous pinions are generally affected by the conditions of the weather, moisture being readily absorbed. Special precautions to treat the fibre or rawhide, however, lessen the influence of moisture.

The pinion and gear shown in the engraving have given a service of about 18,000 car-miles at an average speed of from 10 to 13 miles an hour. They were protected as well as possible from the dirt and dust of the road-bed by canvas truck coverings, but it is evident that the grit intermixed with the grease played a large part in the wear shown. The pinion was composed of rawhide and steel.

DEFINING "SECONDARY," "PRIMARY" AND "STORAGE" BATTERIES.

BY FREDERICK RECKENZAUN.

In The Electrical Engineer of April 9 is an article in which the author, Mr. E. R. Knowles, offers a definition of the terms "secondary," "primary" and "storage" batteries and "accumulators," the main object of which appears to be the exclusive assignment of two of these terms to a class of batteries which have thus far acquired comparatively little practical importance, namely, primary batteries capable of being regenerated by the action of an electric current.

While the selection of an appropriate designation for this class of batteries may be quite desirable, for the sake of distinction, it seems hardly advisable to borrow for this purpose from existing terms, the meaning of which has been so well established and so universally adopted. Whatever controversy there has been aroused, now and then, by the attempt to draw a distinct line between primary batteries on the one hand, and devices known as secondary or storage batteries, or electrical accumulators, on the other, the three last-named expressions have always been accepted as perfect equivalents.

In France, Germany, Austria and other countries, electrical literature avails itself of the terms "secondary batteries" and "accumulators" absolutely without an idea of distinguishing between them, the latter being the more generally employed where both are not used in conjunction. In England, and in this country, the same usage prevails, only the term "storage batteries" having been added as an equivalent which, although perhaps less appropriate from a scientific point of view, has found very ready acceptance in the language of practice. The desirability of having two or three terms to designate the same thing, may be questionable, but we find numberless precedents everywhere to disarm our objections. It is certain that confusion would be created by separating "secondary battery" from "accumulator" and "storage battery," to use the first named alone for the designation of the familiar device, while "stealing" the other *two* for the obscure object that so often furnishes the bone of contention when comparison is made between "primary" and "secondary" batteries.

If we are to have one term only for the latter, then let us drop the other two altogether,—although time may itself do the sifting—but do not let us make matters worse by lending the other familiar terms a new meaning.

If necessary, a new and more appropriate name could undoubtedly be found for that third class of batteries having properties of both the others; this would at least avoid stamping existing literature with confusion.

HENRY'S FIELDLESS MOTOR.

In the development of the modern dynamo and motor many hundreds of different patterns have been brought out, but through all of the designs it is not difficult to trace relationship between them and older members of the family. But a decided departure from the usual type is a form of motor recently designed by Mr. John C. Henry for street car work. This consists of a motor without fields, but having, instead, a plurality of armatures, with their brushes placed so as to cause a mutual action and reaction between the magnetic poles of the separate armatures. The object of the design is to make a machine of light weight capable of being self-sustained on a car axle.

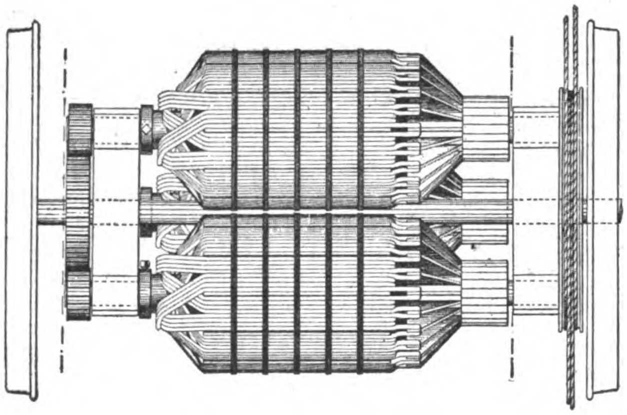
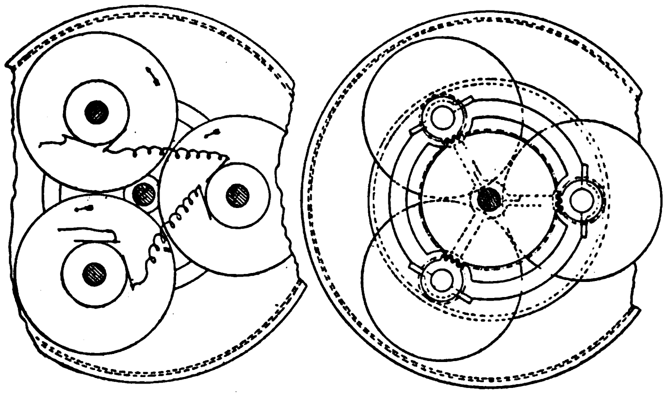


FIG. 1.

In the accompanying engraving, Fig. 1, are shown three armatures so mounted in a triangular frame, and supported loosely on a car axle. The armature shafts carry pinions which engage with a spur or internal gear which is keyed to the car axle, as shown in Fig. 2. On the opposite end a friction wheel is secured to the carrying frame. Around this friction wheel are placed wearing shoes and a cable which extends to the brake stems on the car platform.



FIGS. 2 AND 3.

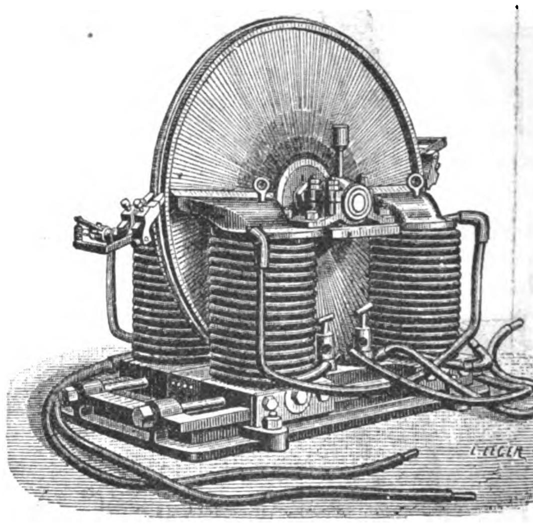
Ordinarily, under the influence of the current, the armatures turn around the car axle as well as on their own shafts, the former remaining stationary; but if tension is applied to the cable, the carrying frame is retarded or held stationary, and the car wheels are driven. By allowing the clutch to slip, the car speed is varied.

The illustration, Fig. 3 shows the arrangements of the brushes, which are placed 60 degrees apart, the armatures being connected in series.

We may add that the motor illustrated is now undergoing tests with both alternating and direct currents, and the results obtained are said to be very encouraging.

THE POLECHKO DISC DYNAMO.[1]

At a recent meeting of the Congress of Russian Naturalists, M. Polechko described a form of dynamo of the disc type, which involved some novel methods of construction. The armature of the dynamo, as shown in the accompanying engraving, consists of a single piece of metal, one metre in diameter, insulated from the shaft, and cut radially into 350 segments, separated from one another by fibre to within 13 centimetres of the shaft. The periphery of the disc is furnished with a steel rim, insulated from the disc itself, and widened out on either side of the disc, so as to serve as a collector.



THE POLECHKO DISC DYNAMO.

In the first machine, constructed after this pattern, with a magnetic field, equal in intensity to 6,500 C. G. S. lines, an E. M. F. of 25 volts and 2,000 amperes was developed at a speed of 1,500 revolutions per minute, its weight being 1,140 kilograms, (about 2,500 lbs). While more particularly adapted for electrolysis and electro-metallury, the inventor hopes to increase the voltage so as to make it applicable to electric lighting.

THE FRANKFORT, GERMANY, ELECTRO-TECHNICAL EXHIBITION OF 1891.

This exhibition will be opened on May 15, 1891, and will close on October 15. The exhibits will be classified under twelve sections:—I. Motors for electro-technical purposes. II. Generation of electricity. III. Conductors and auxiliary apparatus. IV. Accumulators and switches. V. Transmission of electric power. VI. Electric lighting. VII. Telegraphic and telephonic apparatus. VIII. Electric signaling. IX. Electro metallurgy and electrolysis. X. Measuring instruments. XI. Medical electricity. XII. Electro-technical literature. Applications for space must be sent to the executive committee before July 1, 1890. The delivery of exhibits which will require some time to erect may commence on March 15, 1891, and must be completed on April 15. Other exhibits may be sent in up to May 1. The charges for space are as follows:—A. Main building, 15 marks the square metre (about $3.25 per square yard.) B. Semi-covered space, 10 marks per square metre. C. Open air, 2 marks per square metre. The cost of insurance is to be paid by the exhibitors. The charge for power will be 3 cents per horse power hour, 3 h. p. being the minimum.

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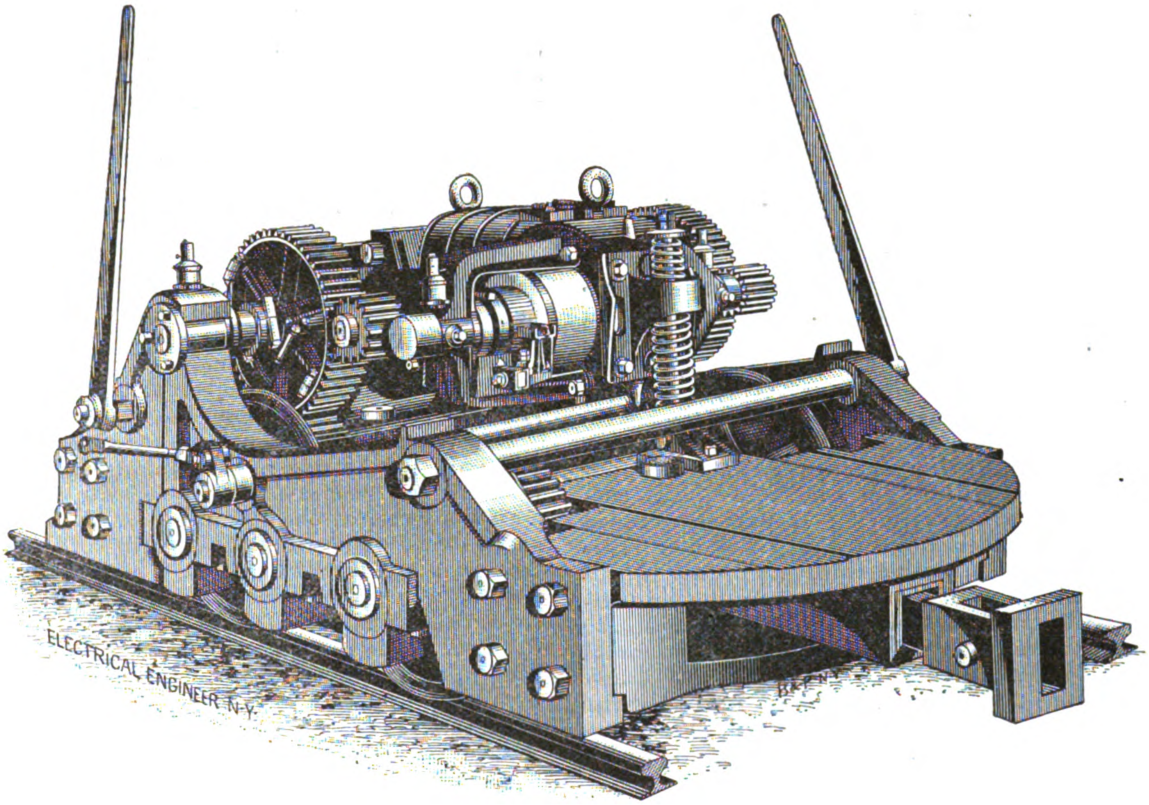
[1] *La Lumière Electrique.*

A SPRAGUE MINING LOCOMOTIVE FOR SWEDEN.

The attention which has been given to the application of electricity in mines has already evolved distinct types of apparatus for this class of work, which requires the fulfillment of some very exacting conditions. The application of the electric locomotive alone, for the propulsion of mining cars has called forth a variety of designs. As our readers are no doubt aware, considerable attention has been devoted to this branch of electric power application by the Sprague Electric Railway and Motor Co., and one of the latest products in this department of work is an electric mining locomotive which will shortly be sent to Stockholm, Sweden, to be placed in a mine.

The motor, which is illustrated in the accompanying engraving, is of 15 h. p., and of the standard railway type. It is hung in a method similar to that employed in street railway work, and includes the regular Sprague system of flexible suspension, but with the motor geared to both axles.


ELECTRICAL ENGINEER N.Y.

A Sprague Mining Locomotive for Sweden.

The electrical control of the motor is effected in the regular way by the use of a railway switch, which is placed on top of the box covering the motor, and which has handles on each end, so that the motor can be controlled from either end of the car. In the engraving the motor is shown with the covering box removed. There is also a brake lever at each end of the car, and the entire control of the car is effected by means of the electrical switch and brake.

The arrangement of the switch is such, that the motor can be run at any speed, from the slowest crawl to full speed, by varying the position of the switch through an arc of 150 degrees. The same switch reverses the direction of the motor and the car by moving the handle of the switch in the opposite direction.

The current is carried to the car by means of a single electric circuit, the underneath trolley contact being used. The draw bar is arranged to swing over quite a large arc, so as to accommodate the trail cars when going around curves. The gauge is 36 inches, wheel base, 26 inches, with the draw bar about 12 inches above the track.

TELEPHONY AT THE WOMEN'S EXCHANGE EXHIBITION.

The exhibition organized under the auspices of the Exchange for Women's Work at the Lenox Lyceum in this city, contains besides the exhibit of Mr. Edison's apparatus and the many beautiful lighting effects, another very noteworthy and interesting feature contributed by the American Telephone and Telegraph Co., who operate the long distance telephone lines which are now rapidly extending over the country. The exhibition contains what is probably the first systematic attempt to afford an opportunity for allowing a large number of people to listen to telephonic reproduction of a theatrical performance and the reproduction of musical solos and speech from a distant city.

As an example of what has been done in this direction we may note that every evening trumpet solos, singing and speech, direct and phonographic, are transmitted from Boston to the Lyceum a distance of 254 miles, in such a manner that 80 people are enabled to listen to the sounds at one time. That this is a remarkable achievement will be admitted when it is considered that besides traversing more than 500 miles of copper wire circuit the current passes through eight miles of cable. The articulation which we have had opportunity to test, is remarkably clear. This is specially noteworthy in the case of a transmission by a loud-speaking receiver which gives the sounds with remarkable purity and discernible easily by the ear at a distance of several feet.

Experiments have also been successfully tried in transmitting the reproduced speech by phonograph from Boston to Syracuse, via New York. This was accomplished on an evening devoted to the New York State Press Association when representatives of the press in the western part of New York were gathered at Syracuse and heard the sounds uttered in Boston.

Besides this remarkable exhibition of the power and possibilities of the long distance telephone and the long distance system generally, the public is also, with the aid of the Metropolitan Telephone Co., treated to an excellent exhibition of the manner in which the performances of theatres and concerts can be brought to their houses. For this purpose transmitters have been arranged at various theatres about the city, among them, at the Casino, where the "Grand Duchess" is now being performed. The plan adopted has been to distribute ten transmitters in the manner indicated in the accompanying diagram, Fig. 1. Four transmitters on each side of the theatre are attached to the boxes and faced towards the stage together with two in the centre of the house, as indicated. The primaries of each two transmitters are placed in series, and connected to two Fuller cells in series, while the secondaries of all the transmitters are connected in multiple arc to the lines running to the exhibition hall. Here there are receiving boards arranged in which the telephones are connected as shown in the accompanying diagram. There are four receiving boards arranged for the public, each board consisting of eight sets of five receiving telephones arranged in series as indicated in the accompanying diagram. This arrangement of placing the receivers five in series was shown after considerable experimenting to be the most advantageous with telephones having a resistance of 120 ohms. This, however, was only for the reception of local transmission; for the connection with Boston it was found more advantageous to place the telephones three in series instead of five. There are thus four boards of 40 receivers each, making 160 telephones which are able to receive transmission originating in New York at one time; while at the same time 13 sets of three each are arranged to receive from Boston. With the additional 'phones on the line there are altogether over 200 receivers connected. This is probably the largest number which has yet been employed in the simultaneous reception of telephonic transmission.

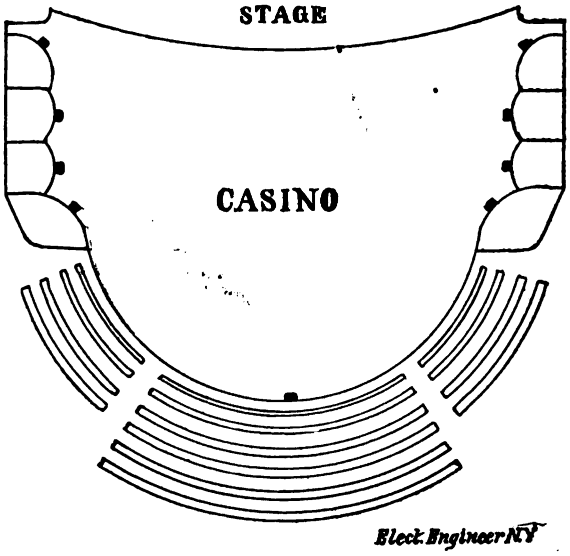


FIG. 1.

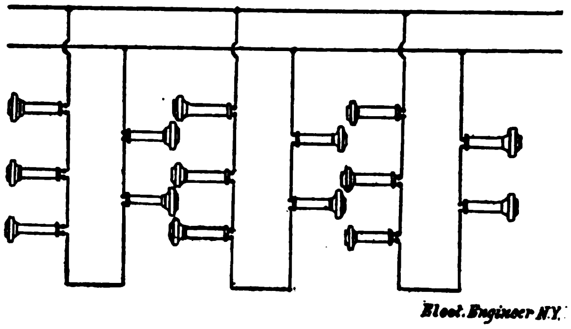


FIG. 2.

The work accomplished here has been of the most thorough kind. Every connection of the switch-board was soldered and okonite wire was employed throughout. There is also a mechanical switch-board employed for the purpose of changing over from one theatre to another, and for throwing in circuits connected to various exchanges.

The installation deservedly attracts a large share of the attention of visitors, many of whom remain for hours listening to the beautiful strains and recitations which come over the line during the entire evening.

The arrangements of the details of this interesting exhibit have been carried out by Messrs. A. S. Hibbard, J. C. Hovey and F. A. Pickernell of the "Long Distance" Co., and the results obtained are in the highest degree satisfactory, proving that the telephone, and especially the long distance telephone, can be made to fill a sphere of usefulness which is but little realized at the present time. The exhibit is nothing short of a revelation, as well to the electrical engineer as to the average citizen.

THE NEW HOCHHAUSEN ARC LIGHT MACHINE.

THE various systems of arc lighting employed have seen comparatively little variation in the form of the dynamo employed in the past few years, and, indeed, it had almost come to be taken as an accepted fact by many that few changes would be seen in the near future. That the industry is, however, by no means one incapable of improvement and modification in apparatus as different needs become apparent, is evidenced by the fact that a machine of decidedly novel type is now ready to be placed before the public.

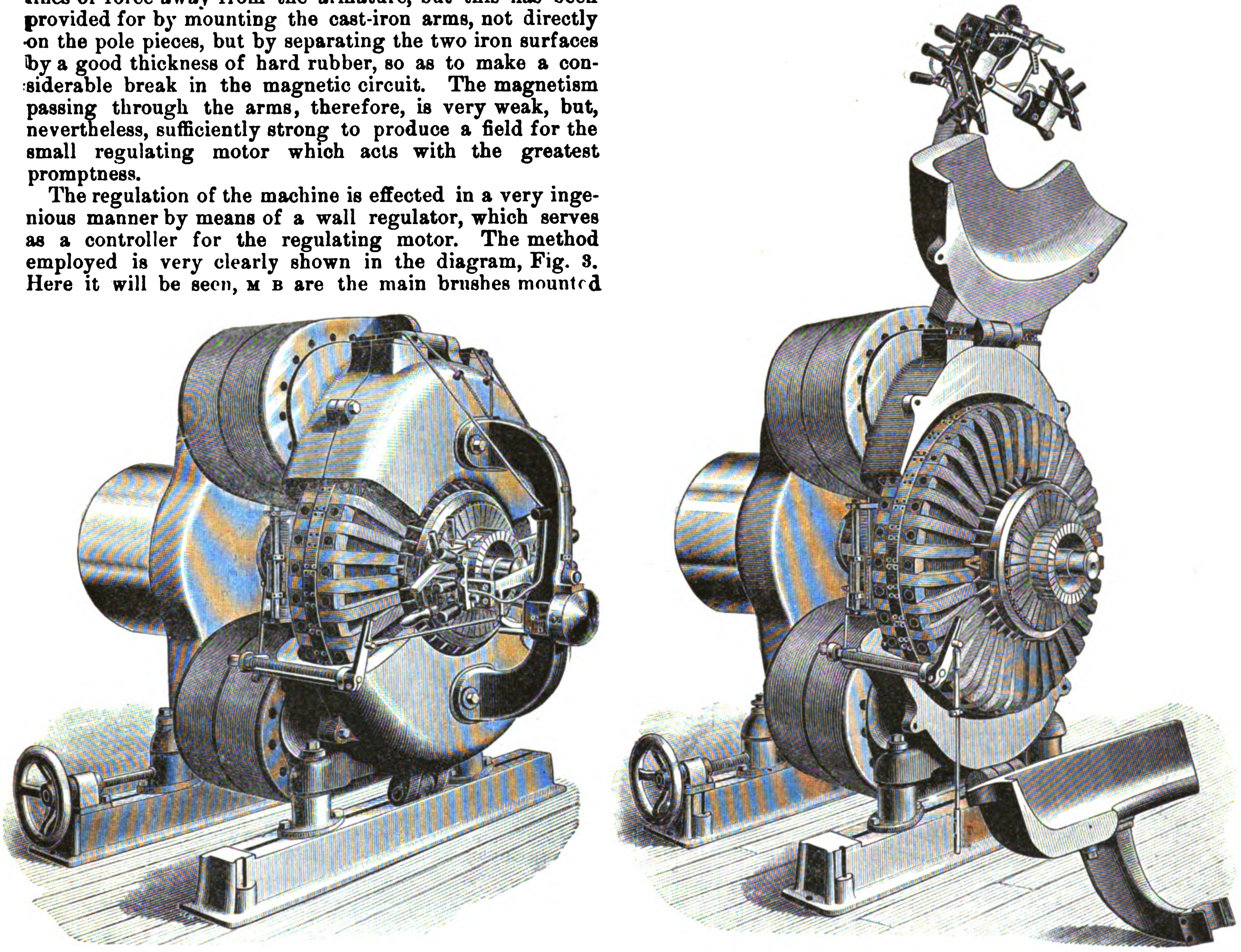
The designer of this new machine, Mr. William Hochhausen, electrician of the Excelsior Electric Co., was among the first to engage in the arc lighting industry, and is the inventor of various types of machines. His last effort in this direction embodies his mature experience, and as such, presents a considerable number of interesting departures from the type of machine at present in use.

Beginning with the magnetic frame of the machine, it will be noted by referring to the accompanying illustration, Fig. 1, that it consists of two field cores connected by a cast-iron yoke at one end and provided with pole pieces at the other, which encircle the armature on three sides. The armature, it will be noted, is so placed that its shaft rests in bearings which are on the interior of the machine, so that the armature, as exhibited in Fig. 2, can be entirely exposed. This is facilitated by the pole pieces which are hinged, as shown, and which can be turned out so as to expose the armature completely, and allow it to be drawn out a sufficient distance for thorough repair, if necessary, without removing the shaft from the journal bearings.

The armature core is built up of iron wire, insulated by paper, the wire being wound on a cast-iron frame or skeleton having a T section which divides the core into two parts. The arms of the spider which holds the armature are insulated from the core and frame, and fit into notches which are cut tapering from both sides towards the centre, so as to keep the whole concentric.

The coils of the armature which are rectangular in section, are wound automatically upon the core by an ingenious machine devised by Mr. Hochhausen for that purpose. When placed upon the armature core the coils are separated on the outer circumference by wooden wedges, which are secured to the cast-iron skeleton of the armature, and they are held in position by sections of fibre band which are screwed into the wooden wedges just referred to.

The regulation of the machine is a development of the methods heretofore employed by Mr. Hochhausen and is very ingeniously carried out, consisting both in the shifting of the brushes in conjunction with a regulating resistance, both of which are simultaneously operated by an old device originated by Mr. Hochhausen, namely, a small auxiliary motor. This motor which is entirely hidden from view is situated in the hub-like projection bearing on the arms which span the two pole-pieces beside the end of the armature shaft and which might be mistaken, except on closer scrutiny, for the bearing of the shaft. This small motor is fixed in a magnetic field, which is produced by attaching the cast-iron arms shown to each pole piece and bringing them together so as to surround the armature of the small motor. It might be thought for an instant that such a bridging of the magnetic circuit would take a large number of the magnetic lines of force away from the armature, but this has been provided for by mounting the cast-iron arms, not directly on the pole pieces, but by separating the two iron surfaces by a good thickness of hard rubber, so as to make a considerable break in the magnetic circuit. The magnetism passing through the arms, therefore, is very weak, but, nevertheless, sufficiently strong to produce a field for the small regulating motor which acts with the greatest promptness.



Figs. 1 and 2.—The New "Excelsior" Arc Light Machine.

The regulation of the machine is effected in a very ingenious manner by means of a wall regulator, which serves as a controller for the regulating motor. The method employed is very clearly shown in the diagram, Fig. 3. Here it will be seen, M B are the main brushes mounted upon a rocker arm which is provided with a circular rack which meshes with a pinion attached to the end of the shaft of the small motor regulator.

Starting from the positive terminal of the machine, P, the current is led to the binding post 4, on the wall controller and from there passes into the controller magnets, M M. After traversing these magnets the current enters the armature, A, and after passing through the resistance, R^1 goes to line and the external circuit to the negative terminal N, and main brush of the machine.

It will be noted, however, that the end of the controller armature A, bears against two contact points C C^1, which are connected through points 2 and 3, to the brushes of the small regulating motor on the machine. At the same time the two latter circuits are tapped at points P^2 and P^3, and connected through German-silver resistances, R^3 and R^2 to the terminal 1.

Now the regulating magnet, M M, is so adjusted that when the normal current passes over the line, the armature A stands horizontal and makes contact with both points C C^1, which are fixed at the end of the lever B. The current entering the armature A from the magnets M M, therefore, besides passing to line through the resistance R^1, has two other paths open to it, through contacts C C^1, to the brushes of the small regulating motor via points 2 and 3. But it will be remarked that the currents in these two circuits are in the same direction and when they meet at the regulating motor oppose each other, with the result that they have no effect on the little motor, the armature of which remains stationary. It will also be noted that a part of the regulating current passes to line through R^2 and R^3.

Now, if from any cause an increase of current takes place above the normal, the armature A of the wall controller is drawn down out of its horizontal position, by which action the contact at C is broken, while that at C^1 is still maintained. The regulating current now has only one path open to it from C^1 to 2, 2, etc., to the left hand brush of the motor regulator, thence through the armature to the other brush to points 3, 3, P^3, and out to line through the resistance R^2. This affords a complete and continuous path for the regulating current, and the motor armature at once starts to revolve and to turn the brushes of the machine in the corresponding direction for cutting down the current; at the same time the rod FF acts upon the field switch S, which assists the brushes in reducing the current by cutting out sections of the field magnets.

When the normal current has again been established the controller armature re-establishes contact, C, and the regulating motor stops. A diminution of the current from the normal causes the breaking of the contact, c^1, which sends the regulating current through the motor in the direction opposite to that just described, and with a corresponding effect. It will be evident that at all times the resistances R^1 R^2 and R^3 are in circuit, and as the last two points form constant shunts to the points C and C^1, no sparking whatever takes place when contact is broken at either of those points.

The result of this is, that upon any variation in the current, not only are the brushes revolved in a corresponding direction by the regulating motor, but, as will be noted, the field switch S is operated, to cut sections in or out, by means of the connecting arm F F; both these methods of regulation acting in conjunction serve to bring the machine instantly into its normal state.

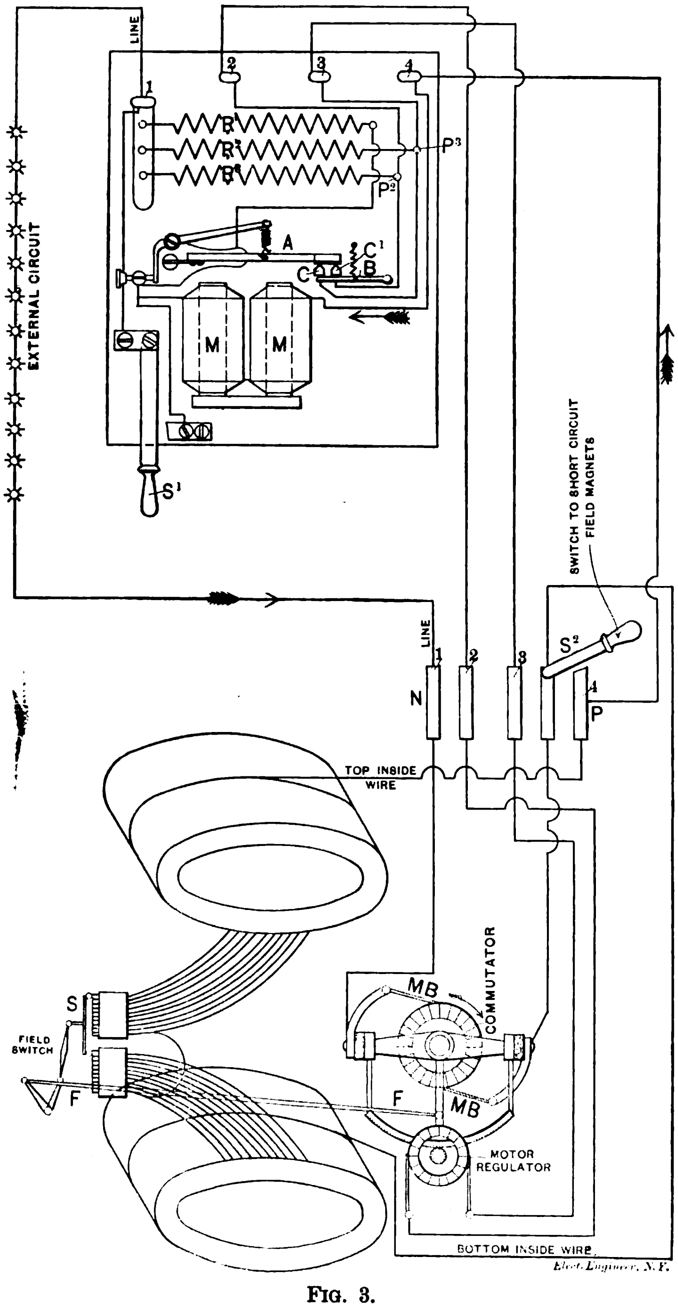


FIG. 3.

An experiment which we witnessed with the machine fully demonstrated the reliability of the device, even when the full complement of lamps were thrown on and off instantaneously.

The switch s^1 is provided for the purpose of cutting out the regulating motor when adjusting the position of the magnets M M; while the switch s^2 is employed for short circuiting the field magnets when shutting down the machine.

As the potential employed on the largest sized machine approaches the neighborhood of 5,000 volts, extra precaution must be taken for insulation of the various parts, which is made especially necessary by the static charge which has opportunity to accumulate from the friction of the belt. The jumping of the spark due to this accumulation is apt to be followed by the current from the machine. To avoid this the armature is thoroughly insulated with mica from the spider which holds it and the bearings are also insulated from the main body of the dynamo, and the latter again from the iron skids upon which it is mounted.

Various sizes of this machine have been built, the largest, designed for 125 1,200 candle power lamps, or for 100 2,000 c. p. lamps. The diameter of the armature of this machine is 30 inches and has 36 coils wound upon it, each eight inches square. 160 pounds of No. 17 B. & S. wire are wound on the armature for the 1,200 candle power lamps, which require seven amperes, and the same weight of No. 16 wire, where the 2,000 candle power lamps are employed, which take 10 amperes. The speed of the machine is 700 revolutions per minute and its total weight 5,500 pounds.

The field is wound with 1,300 pounds of No. 8 wire divided into two sections. One of these is wound unbroken, while the other is tapped at equal intervals by 20 wires which are connected to the field switches and controlled by the brush rocker in the manner described above.

The second size of this machine constructed is designed for 50 lights of 2,000 candle power each and has 90 pounds of wire in the armature and 870 on the field. The third size, designed for 30 lights, has 55 pounds of wire on the armature and 400 pounds on the field.

The general appearance of the machine, it will be noted, is exceedingly compact and the open construction adopted allows of ready access to every part for examination and repair, if necessary. The machines have already been placed in several stations where their operation has been attended with marked success.

GUTTA-PERCHA-COVERED WIRES IN CEMENT CONDUITS.

In an article in the *Annales Telégraphiques*, M. Scheffer, in describing the repairs which he has lately been carrying out on the subterranean lines in Maurienne (Savoy), calls attention to the deterioration of the gutta-percha insulation of wires laid in cement conduits. "The gutta-percha is in most instances impaired, and in consequence the thickness of the dielectric is no longer sufficient to prevent disruptive discharges where high-tension currents are employed." The wires in question were laid in 1885.

SPECIFIC INDUCTIVE CAPACITY OF RAREFIED AIR.

In a recent paper[1], Dr. James Moser, has shown that, while air rarefied to the extent common in Geissler tubes, is a conductor, a high vacuum is really an insulator. It was of interest to determine the specific inductive capacity of air in these two states, and with this view a Leyden jar was constructed with air as the dielectric. A Geissler pump was placed in communication with the condenser, and also with Dr. Moser's double vacuum tube already described. The former was used to rarefy the air, and the latter, when excited by an induction coil, to indicate by its appearance the state of rarefaction. Both were disconnected from the condenser when the capacity measurements were taken. A Mascart-Carpentier electrometer was used, whose capacity was comparable with that of the air condenser. The quadrants were charged with a Latimer Clark's cell, and the needle by commuication with the air condenser, which had been previously charged by means of a Zamboni pile. The deflections produced should vary with the specific inductive capacity of the rarefied air, since the potential of the Leyden jar must fail, on being connected with the needle, by an amount depending on the ratio of the two capacities. The results obtained by Dr. Moser were, however, negative, no certain variation in the deflection being estalished.

. . .THE first requisite for an observer is that his mind should be actively awakened to the phenomena of nature with which he is surrounded.—*Joseph Henry.*

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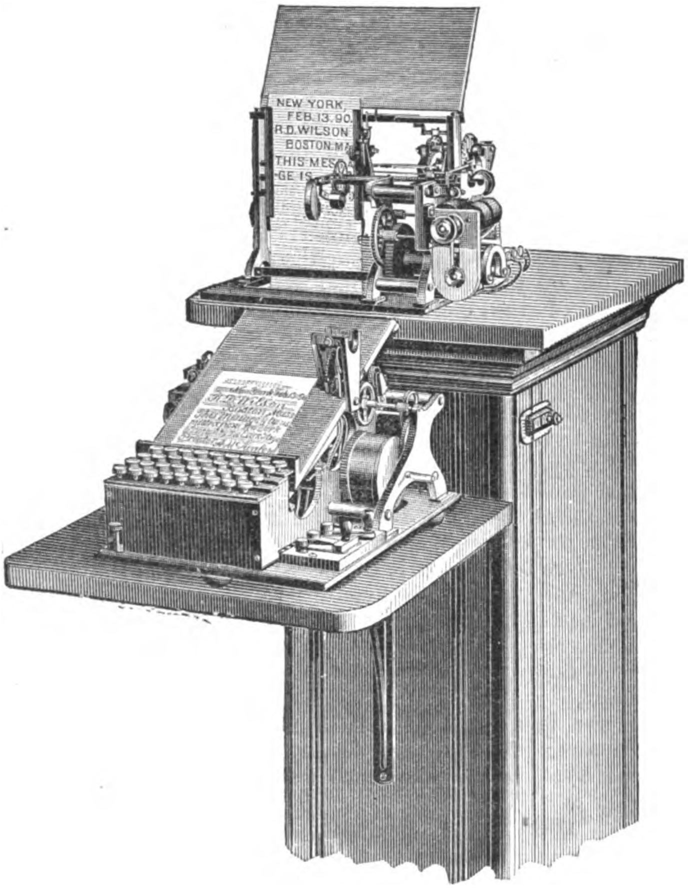
[1] THE ELECTRICAL ENGINEER, April 9.

THE ESSICK PRINTING TELEGRAPH.

There is now in daily operation between Boston and this city a system of printing telegraphs, the invention of Mr. S. V. Essick, which possesses a number of novel features, and is intended to place in the possession of brokers, merchants, and the public generally an instrument, which, while combining the well-known features possessed by the usual printing telegraphs, has additional advantages which make its use very convenient.

Printing telegraphs have, as a rule, been associated with the employment of a long tape upon which the news is received, and which for reference frequently requires the going over of many yards in order to obtain the information wanted; at the same time the length of a message of any considerable extent is inconvenient, and for filing purposes the tape is evidently an awkward arrangement. In the Essick instrument this has been overcome by an arrangement very clearly illustrated in the accompanying engraving. Instead of employing the tape heretofore used, a paper roll is employed having a width of 4½ inches, upon which the letters are printed in lines the width of the roll, so that they can be read in the same manner as a page of ordinary print.



The Essick Printing Telegraph.

The instrument, it will be seen, consists of a receiver which is operated by impulses received from the line through a polarized relay which operates a type-wheel. Fourteen impulses represent the entire alphabet, making a complete revolution of the type-wheel, which is capable of turning 200 revolutions per minute, and by which it is claimed 50 words a minute can be printed.

The roll of paper, which is continuous, is held in a frame which travels one space for each letter printed, and at the end of the line is automatically shifted back to the beginning of a new line, and at the same time advances the space dividing two lines. The operator handles a keyboard, so that any one can in a very short space of time become conversant with the operation of the instrument, and which therefore requires no special operator for its working.

In this new system the impulses move the instrument, and operate at the same time all the other instruments on the line. Any break in the wire, therefore, opens the circuit, which entails the breaking of the communication, so that the operator immediately becomes aware of it. The system, it will be seen, is so arranged that the transmitting operator records the message, not only at the other end of the line, but also at his own instrument, so that there is constantly available a copy of all the messages sent. The duplicating of the order transmitted by the copy at the transmitting office is evidently a valuable feature in many departments, especially in railroad work, as it affords a check upon all orders transmitted.

Any number of receivers can be placed on the circuit and operated by a single transmitter so that news can be sent to various places at the same time. A single line is employed in transmission and we have recently had occasion to witness the work of this instrument between this city and Boston, the result of which proves the same to be a valuable addition to the present methods of communication.

The system is now being operated by the Essick Printing Telegraph Co., of this city, and has been brought to the attention of the Congressional Committee now investigating postal telegraph facilities.

"MUNICIPAL" LIGHTING AT MARQUETTE, MICH., AND BANGOR, ME

The following table shows the lamp capacity of plant and lamps in use during the month of January in Marquette, Mich.:

ARC LIGHTS.

Capacity of arc dynamos, 124 lamps

Used for street lighting	60
Used by private consumers	22
Used at power station	1
Total	83
Remainder yet available	41

INCANDESCENT LIGHTS.

Rated capacity of dynamo, 750 16 c. p. lamps.

Number of lamps in use, all candle powers	769
Total number on 16 c. p. basis	837
Excess over rated capacity	88

The following table shows receipts from all sources for January:

From city, 60 arc lamps	$200 00
From private consumers, 22 arc lamps	128 00
From private consumers, 727 incandescent lamps	247 32
From water board and city, 32 incandescent lamps	4 68
Total	$580 00

The cost to the city for operating the plant and interest on bonds issued to establish it were as follows, for the month of January:

Wages, engineer, assistant and trimmer	$185 00
Carbons	40 00
Oil, waste and fuel	15 00
Repairs, breakage and incidentals	35 00
Interest	166 66
Total	$441 66

The plant is still capable of furnishing 41 more arc lights, which at $6 per month amounts to $246 more. The incandescent dynamo can carry 173 lamps more, which would bring in from $100 to $150 more per month.

A "VOTER," in writing to the Rutland (Vt.) *Herald*, says "Below is a sample of how villages are deceived regarding the cost of putting in electric light plants, to be operated on municipal account, and Bangor (Me.) is selected as the instance. Its city charter enables it to use certain water power. Assuming this power to be sufficient, an estimate was made of $17,000 to equip the city with a plant of its own, and afterwards $3,000 was added for contingencies, whereupon the city committed itself to the scheme. The lowest bid received, however, was reported at $26,000. The water power was found inadequate, requiring a steam plant in addition, costing $5,000, and an additional $10,000 is now required to make the plant answer the city's needs, or in all, $41,000, as against the estimate of $20,000 on which action was first based. Do the taxpayers of Rutland want to be burdened with more taxes for a wild scheme of this kind?"

THE TELEGRAPHERS' FAST SENDING TOURNAMENT.

BY PATRICK B. DELANY.

As there are forty or fifty thousand people talking about the young Yankee Pollock, who brought his bundle of thews and nerves down from a Connecticut town, and coolly stretched the record out of reach at the fast sending tournament, we might as well see what this cheeky manipulator really did. In his first trial he poured out a stream of dots and dashes to the tune of 51⅘ words per minute, and then, like Mark Twain's coyote, when his speed was questioned, let out another link in his backbone and shoved the record up to 52 words per minute, making 260 words in the five minutes given to each contestant. It is claimed, and with some reason, that the work was not plain and perfect. I know that the sending of Messrs. Gibson, Ayres, Waugh and Bradt was vastly superior as to quality, and of such a character as not to fly off the poles in turning sharp angles; but still, I think the "Yankee Blade" made all the signals, and that the lack of clearness so noticeable, was, in a great measure, due to the great speed, and his lightness of touch.

It has been the custom heretofore for commercial operators to turn up their noses at the railway operator, and Pollock seems to have made up his mind to avenge the slights and indignities so long and lavishly heaped upon his train-guiding brethren. Admitting that his juggling of the signals had many of the characteristics of a railway accident, still, every time I caught the thread of his discourse I found him putting it all in honestly. I couldn't follow him all through. Even the air-brakes seemed powerless to hold him. He was a sort of runaway train going down grade, and if the time-keeper hadn't opened the switch on him, there is no telling where he would have fetched up. Now, if Pollock, Jr., made all the signals, I claim that, regardless of classicality, he has performed a wonderful feat, and I am strongly of the opinion that so great a number of impulses, of any kind, have never before been made in the same time.

I have been experimenting a little since the tournament, with a view of ascertaining whether, if Mr. Pollock had made all dots, he could have crowded any more into his record than the number of mixed dots and dashes credited to him; and I have come to the conclusion that the almost infinite number of changes involved in the transmission of the English language by dots and dashes is restful to the operator, and that if he were compelled to make the letter "p" or figure "6," consisting of all dots, at top speed, for five minutes, his muscles would be practically paralyzed. It is easily tried. Others may find it different.

Since Fast Sending Tournaments promise to increase in interest from year to year, I have no doubt that certain improvements will be made in their arrangement which will contribute to the speed of the operators and to the certainty of decisions by the judges. Nothing was plainer than the consideration and fairness of all connected with the tournament just closed, but when writing climbs up into the fifties, it becomes very misty, and faults are difficult of detection. I have many times tested the limit of sound reading by using a punched strip and machine transmission. Sixty to sixty-five words per minute can be followed, if the matter be familiar to the ear, or with the manuscript before the listener, but this must be from a strip carefully punched. I think therefore that a Wheatstone recorder should be used for receiving the writing of each contestant. This instrument, properly adjusted, will record over 500 words per minute, so that there need be no fear of anything being missed. I would suggest also that a condenser be used to prevent sparking at the key points, especially if a considerable number of sounders are to be used in the circuit. It occurred to me and some others that one first-rate sounder placed in the centre of the hall would be more satisfactory than a number scattered about, some well adjusted, others not. With a single sounder there would be a unanimity of opinion regarding the quality of the work.

An analysis of the real meaning of Pollock's wild flight is interesting. It shows that the 260 words transmitted in five minutes call for 1,223 letters and 11 punctuations, or say 1,234 letters in all. To make these letters 2,834 impulses were required. This puts over nine impulses into each second, and as each impulse calls for a down and up motion of the key, the hand and fingers of the "Railway Guide," from Hartford, had to make nearly 19 movements per second for 300 consecutive seconds. If any one thinks he carries more agility than this about his person, fame awaits him—if he is not mistaken.

I doubt very much if there be any one living able to write out words at this speed. Forty-five words per minute will claim any man's undivided attention, so that until the penmen can put more steam into their fingers, Pollock's gait would be useless, even if it could be maintained—which it could not. It is fair to assume, however, that a man who can do 52 words per minute in any shape, might send grandly at the rate of 45 words per minute. If the elder Catlin's pace and beautiful style of transmission were general throughout the country and there were receivers to put it down, the earning capacity of the telegraphs would be just about doubled. Here is something for managerial meditation. There is money in it. When a boy like young Catlin, not yet old enough to vote, can double the work of an ordinary circuit, he becomes a duplex. He should be encouraged.

To my mind the great speed and general excellence of the work of the young women, was the most remarkable feature of the contest. It was a revelation to one who has not been very close to the sounder for some years. I considered 32 or 33 words per minute the winning speed in their class, but how the glory of old times faded when 43 and a fraction were poured out with ease and grace without untying a bonnet string. I think the quality of the young women's work averaged higher than that of the men.

I find that there are 636 dashes in the 260 words sent by Pollock, or an average of about one dash to two letters. Five letters to a word is the usual way of reckoning. If Pollock had to furnish five letters to a word, his score would be 246⅘ words. But 4¾ to 4⅞ is nearer the average. This may be proven by counting the letters and words in a few columns of the editorial page of the New York *Sun*, any day.

In the first 50 words of the 260 there are 600 Morse characters; in the second 50 words, 566; in the third 50 words, 531; in the fourth 50 words, 532; in the fifth 50 words, 503, and in the 10 words which distinguished Pollock, there are 102 characters. There is a difference of 97 characters between the first 50 words and the fifth. This is equal to five words. As young Catlin sent 251 words and one letter, or 2,738 characters, he is just 96 characters behind Mr. Pollock.

Here is what was done by each contestant,—the names being in the order printed on the official programme.

Ladies' Class.

	Words.	Characters.
Millie Moss	191-4	2,156
T. V. Froschel	200-5	2,241
B. M. Dennis	212-4	2,328
K. B. Stephenson	217	2,367
Annie M. Schaffer	193-2	2,176
J. Schlesinger	207	2,296
E. V. N. Garthwaite	201	2,245
M. C. White	169	2,003
L. Wagner	185-4	2,096
A. E. Findley	193	2,170
M. A. Daley	186-1	2,099
E. R. Vanselow	210-4	2,327
S. C. Barry	197	2,196

Old Timers.

	Words.	Characters.
J. H. Dwight	138-7	1,553
Fred. Catlin	217	2,367
A. S. Ayres	229	2,514
G. M. Eitemiller	197-4	2,215

Class A.

	Words.	Characters.
A. J. Swan	215-2	2,342
F. L. Catlin	241-1	2,635
F. L. Catlin (second trial)	237	2,602
H. S. Wright	203-2	2,267
H. D. Paulhamus	218-7	2,391
W. L. Waugh	229	2.515
J. P. Bradt	224	2,464
W. Davis	195	2,187
W. Davis { 2d trial on acount of time error. }	194	2,175
M. H. Toomey	230-4	2,530
J. W. Roloson	248-3	2,707
J. W. Roloson (second trial)	246-2	2,682
R. B. Pollock, Jr	258	2,811
R. B. Pollock, Jr. (second trial)	260	2,884
W. M. Gibson	239	2,622
W. M. Gibson (second trial)	238-4	2.617
U. Peters	217-2	2,411
F. J. Kihm	238	2,609
G. W. Simmonds	221-1	2,446

Class B.

	Words.	Characters.
W. L. Waugh	229	2,515
Ed. Bishop	193-3	2,178
J. G. McCloskey	209	2,305
A. J. Swan	212-8	2,354
Frank English	225	2,471
H. S. Wright	211-1	2,334
D. Wark	224-1	2,464
H. D. Paulhamus	224-1	2,464
M. J. Doran	213	2,359
M. H. Toomey	228-6	2,510
F. L. Catlin	251-1	2,738
R. C. Mecredy	220-2	2,442
W. A. Jones	223	2,461
O. Hart	222	2,456
J. P. Bradt	220-2	2,447
C. W. White	218-8	2,429
A. S. Patterson	201-4	2,248
J. D. Hinnant	214	2,356
F. F. Norton	211	2,333
E. A. Sprong	208	2,256
W. Davis	193	2,170

There were 13 women and 34 men in the contest. Taking the highest figures of each contestant they foot up a total of 9,955 words transmitted, or an average of nearly 42⅓ words per minute for each of the 47 operators. The women averaged 39⅜ words per minute, the men 43⅓. All praise to the ladies. Great is Pollock.

THE EVOLUTION OF THE ELECTRIC RAILWAY.[1]

BY JOSEPH WETZLER.

The theory of evolution, as now generally applied to organic life, has reached a point of development where it may be considered to have almost attained to the position of established permancy, and which the many facts adduced all tend to strengthen. While the theory is applied to man, in so far as his bodily organism is concerned, it may be claimed to go further, and I think it cannot be difficult to trace its processes not only to the whole organism, but to the products of his brains and hands as well. Every step in advance now recognized as of benefit to mankind has been the result of an evolution of thought combined with an evolution of practice. Take for example, the steam engine. What changes has it not undergone, and what form has it not assumed since the day of Watt? Consider, if you will for a moment, the various types into which it has differentiated, each of which is best adapted for certain conditions, localities and circumstances, quite analagous, indeed, to the way in which Darwin and Huxley have pointed out the variations which changes of locality, climate and proximity to natural enemies have brought about variations in the animal species. To this general evolution which is constantly going on both in the material and the spiritual world, the electric railroad is no exception.

In order to be logical, let us briefly refer to the past for the purpose of making our record complete. History tells us that as far back as 1835 attempts were made at electric locomotion, and for 40 years spasmodic efforts in this direction can be traced through the annals of electricity, including the work of a number of men, among whom American inventors are by no means the least conspicuous. What were the elements in these early locomotives? They were, first, the electromagnetic motor, and second, the primary battery. The combination of these two crude, or, as we may say, rudimentary elements, was evidently not calculated to bring the electric railway into the field of practical use. Nevertheless, they were a starting point, and though unsuccessfully worked out, the time and labor spent upon them cannot be said to have been wholly wasted. Indeed, we may consider, and be able to show later on, how a succeeding development may, by force of circumstances, revert to an original form long extinct or forgotten. But we must pass on to the time when we find the dynamo to be a *fait accompli*, and the reversibility of the dynamo a well-recognized effect.

With these powerful allies brought to its aid, and, we may add, its natural enemy, the primary battery, at last made harmless, the electric railway received another strong impulse of development, and arrived at what we may call the second stage in its evolution. Let us examine for a moment the elements as employed by the early workers in this field, and constituting what may be called the electric road of 10 years ago and up to, and including, that of recent date.

We have:

1. The generator.
2. The insulated conductor from generator to car.
3. The motor on the car.
4. The gearing from motor to axle.
5. The return circuit to the generator.

Let us take each element separately, and see what changes have been brought about from that period of 10 years ago up to the present. Taking up the generator first, it might be said that it would be difficult to trace any particular change which the influence of the electric railroad itself might have brought about. But even here, we can discern certain tendencies which may show themselves more markedly at a future period, and which seem to evolve in the direction of large multipolar dynamos of comparatively slower speed than the familiar two-pole machine generally employed at the present time.

But we pass on to our second element, the insulated conductor. Siemens, Daft, Edison and Field, and others started out with one rail, or an independent central rail insulated from the ground as their main conductor, connecting generator and car. The restrictions which such a mode of carrying the current obviously placed upon the operations of the road soon became apparent, however, and the step from a conductor placed upon the ground to one suspended above it was but a natural one. What do we find as the first attempts in this direction? The weight of the motor being no longer available as an additional means of insuring good contact between the conducting rail and the wheel bearing upon it, Siemens conceived the idea of employing the split tube, in which a slider acted as a contact device. The inconveniences of this arrangement however, also soon became apparent, and the plain cylindrical wire took its place, and has maintained its position up to the present time. The sliding contact inside the split tube was then converted into a trolley-wheel, which at first, and most naturally, was placed on top of the wire, riding upon and supported by it, the weight of the wheel insuring the integrity of the contact. But the trolley-wheel riding upon the wire was soon found to be accompanied by certain inconveniences, and the next step in this development was to place the trolley on the end of a pole and press it in contact with the wire from below, by which means not only is all strain removed from the wire, but the latter is actually supported during the passage of the wheel in contact with it. This development so briefly sketched here was, however, the result of innumerable experiments, and the various forms which the trolley-wheel has taken in the past would alone make an interesting chapter in a volume descriptive of this work.

While on the subject of conductors, also, we may turn aside to look at the state of the art as far as it includes placing the conductor below the surface of the earth. This was early suggested, but its development has been delayed; not, I am certain, from any inability to successfully settle the problem, but for reasons which you probably are all aware of, and which involve merely financial considerations.

We come now to the motor. Here we find a still larger field than we have heretofore met with, although, in general principles, of course, all the evolutions going on are alike. Starting out with the practice of employing but one motor to each car, time and circumstances seem to have dictated the use of two motors, which are generally in use at the present time, and the reasons for the adoption of which seemed eminently sufficient at the time the changes were made. Principal among these were the facts that by the employment of two machines power was transmitted directly to two axles independently, instead of to one, as theretofore; again, it admitted of smaller machines being employed which could find easier place under the car body; and, for the reason which was once broached, but which we believe the electric railroad has outlived, viz., that in case of the breakdown of one machine, it would allow of the car being brought home by the second for repairs. In connection with the motor, also, and intimately related to it is the method of regulation and the type of machine employed. Starting out with the employment of external resistances placed in the circuit for the purpose of regulating the speed of the motor and car, this differentiated in some quarters into a combination of the field windings of the motor to effect the same purpose, although the method originally adopted is still adhered to by some as being preferable.

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[1] A paper read before the Boston Electric Club, April 14, 1890.

We must leave this point for the present, and pass on to the gearing by which the power of the motor is transmitted to the axle on which the wheels are mounted. While up to the present, the elements that we have been considering were practically new, and, therefore, amenable in the highest degree to the process of evolution, the gearing of the car at once gave a wide scope to the electric railway engineer, by placing at his disposal mechanical devices, many of which had been in current use for years and years in other work, and which his own ingenuity increased in number and changed to suit his own particular needs. As a result, we find that one of the first devices used for transmitting the power from the motor to the axle was by the well-known belt. Then came the friction gear, which, in turn, was followed by the chain and sprocket wheel, and this by the worm and wheel, the direct crank motion, until we arrive at the present most general form, the gear and pinion. Before this point had been reached, however, a multitude of devices, modifications of those above mentioned, were employed or suggested. Even in the method at present in use, what changes have we not seen, and what has not been tried to overcome some of the difficulties experienced, due to the wear and tear, etc., to which such gearing is subjected? I need only refer to the various materials which have been employed for the construction of the gears to make them durable and noiseless, among which, gun metal, raw hide and steel, and others have figured prominently. Unfortunately, thus far, where one material has been found good in one case, it has generally been found defective in another.

We would pass on, however, to the fifth and last element in the electric railway system, that is, the return circuit from motor to generator. The ground return which was the earliest form employed in the modern electric railway, may be well considered to be the prevailing one, for although the rail is brought into service, it is merely as an auxiliary; but, on the other hand, the metallic return is also employed to some extent, and, in some respects presents advantages which cannot be denied, and of which we shall have occasion to say more later on in discussing the probable development in this direction.

We have thus traced in rapid review the changes which the electric railway has undergone up to the present day, and having thus briefly sketched the process, as it were, by which this state of development has been reached, let us follow out the line of thought, and see if we can determine in what direction and in what manner further evolution will take place. Evolution as a rule tends constantly to the production of a higher type,—one which is better adapted than its predecessor to the surrounding conditions. The electric railway may, and I am sure it will, develop into a better and higher type. As Dr. Joseph Cook, of your own city would say, it will harmonize better with its environments. The employment of the word "better" naturally implies a certain inferiority in the present state of the art, and while no one is more impressed with the magnificent progress made during the past decade (progress against heavy odds, ignorance and conservatism, and the antagonism of vested rights or vested wrongs) it would be folly to say that the electric railway of to-day is perfect. Indeed, it would be against the laws of nature, and stamp the art as one incapable of improvement, than which no greater ill could befall it. Electric railroading being an eminently progressive art, therefore, let us see if we can discern in what direction evolution can be looked for. But, before going further I deem it proper to say here, that in what follows I do not wish to be considered as in any way criticising the electric railway system of to-day, for you and I know but too well that even in the present day it stands without a rival. I wish merely to hint at the direction in which still higher perfection may be reached, and this can best be done by taking up the elements in the order first named.

Taking up the generator, therefore, I think it will be conceded that it has even to-day reached such a standard of perfection that little may be expected in the future in the way of an increase in its efficiency, and the changes which do take place will be more in the direction of cheaper construction, and possibly, as the tendency seems to be largely to-day, towards reduction of speed.

But when we come to the conductor by which the motor is fed with the energy necessary for its propulsion, we encounter the element which is indeed one capable of some evolution, and when we use the word "conductor" we mean not only the wire but all those elements which are subsidiary to it, and which go to make up what we may call the conductor system as a whole. I use the word "evolution" advisedly, in contradistinction to the word "development," for while development in detail is naturally to be expected, the process of evolution which the electric railway is passing through at the present time may make entirely unnecessary the existence of such a system of conductors. I imagine that many of you have already divined what I am about to call attention to, and that is, the presence and the possible influence of the storage battery on the progress of electric locomotion.

Though storage batteries may be said to be in successful operation in a few instances at the present day, notwithstanding the difficulties which their employment presents, due, principally, to the large weight necessary for obtaining the required power, is it likely that the art of storage battery making will remain stationary, and that no improvements in that direction are to be hoped for? I certainly cannot bring myself to believe that such is the case; indeed, I am convinced that with the large number of workers in this field, the next five years will produce a battery which will be adapted to railroad work, not only by its construction and durability, but chiefly by its lightness compared with the power which it is able to develop. With such a battery in the field, applicable to the heaviest work, you can well see that the entire complexion of the electric railway situation will be changed, so far, at least, as the question of conductors is concerned.

But, given that the surmise just ventured should not be realized, will the present type of conductor be maintained in the future? The type most generally employed at the present time is the overhead single conductor, carried on a pole, or on span wires; while, on the other hand, the complete metallic circuit is also to some extent coming into use. Already we hear mutterings of complaint from certain quarters relative to the inductive effects caused by the arrangement with the single wire and ground return. Whether or not the change to metallic circuits will be made, will, I think, depend more upon the decision of the courts than on the relative merits of the two systems.

The question whether the conductors of the future in large cities will be placed underground, is, in a certain sense, problematical, in view of the fact before pointed out, that the near future may make the consideration of conductors out of the question by the employment of storage batteries as a secondary source of energy on a car. But again, on the assumption that storage batteries will not be forthcoming, the paths open in the consideration of underground construction lead in various directions. Will it be a pair of bare conductors from which current is taken and returned by means of brushes attached to a car and projected through a slot in the street? Or will it be one of those ingenious methods in which the conductor is insulated throughout, but connected at intervals with the track which it energizes locally at the spot which the car happens to be traversing at any instant? These are questions which it would be difficult to answer.

Still I think it is fair to assume that the overhead system will continue in use for a considerable period of time, even in the largest cities, and the evolution which may be looked for, is a thorough standardizing of all the details. It is not improbable either that the general type of overhead construction may be materially modified by the substitution of a light and graceful truss spanning the street in place of the span-wires now employed. There are undoubted advantages in such a construction, both as regards safety and economy of maintenance. Such a system might also to a considerable extent lessen the number of posts placed in the streets, as it would permit of longer spans than is deemed advisable at present. Again, the conductor system of the future will, I think, largely resolve itself into a system built up of small units or sections intimately connected and interlaced and supplied with independent feeders. Such a system is specially desirable in large cities, where interruptions on one part of the line due to street blocks, fires, processions, or even a break in the circuit, etc., may necessitate a detour of the cars and their massing on other sections of the line. Ample feeder capacity and small sections will thus make a general stoppage of traffic impossible. Unquestionably the place best adapted for the conductor, every thing considered, is overhead.

I must leave those problems to your consideration and, I hope, for your discussion later on to-night, and pass to the next two elements, which we will consider together, that is, the motor and the gearing which connects it with the axle.

Briefly recalled, the present practice may be said to consist in employing two motors, running at high speed, connected to the axles through gear and pinions, which on an average, effect a reduction in speed of 12 to 1. I think we can already discern more than one change which the near future will bring about in both these elements.

Taking up, first, the employment of two motors, I think it is not improbable that we shall find a reversion to the older type to be the next process in the evolution of the electric railway; that is, that one motor will probably in the future be employed to drive the car, connected to either one or two axles. Let us see the reason for this. Although two motors may be built by the same hands, it is a physical impossibility to build two alike. This means that such motors placed on a car and connected to the same switch, and, as a rule, connected in parallel, will act unequally, one taking more current than the other, and introducing irregularities in working which one motor alone would not produce. Again, the loss which takes place on starting the car from rest to motion is almost double, when two motors are employed, as compared with the case where but one is employed, owing to the fact that at the low starting speeds, the motor has not had time to obtain its maximum efficiency of action.

Again, it not infrequently occurs that the car in starting takes anywhere from 50 to 100 amperes of current through the two motors; but I believe that experiments have demonstrated that if one motor alone is employed, the draft of current at the starting would not be nearly as heavy as just indicated.

Again, looking towards the future of heavy city traffic the question also forces itself upon the mind whether accumulated experience may not prove that greater economy is to be obtained in the use of individual electric locomotives or motors, which shall draw a train of two or more cars, instead of the present method of providing each car practically with its own motive power equipment. Take for instance the condition of affairs in your own city. With the different styles of cars, box and open, only one style can be on the road at one time, and of the 2,000 cars probably one thousand are constantly idle. But each of these 1,000 must be fully equipped for work at a moment's notice. This means an enormous outlay practically unproductive of profit and requiring care for its proper maintenance. If individual motors were employed, only 500, say, would be required, to draw any style of car a number at a time, the cars being of the ordinary type without motor equipment. This is an important question which, I think, will soon command prominence, and which would be an apt example of reversion to a type practically extinct at the present day, though the first employed.

Passing on for a moment to the method of connection of the motor to the car axle, I believe that those persons who have had practical experience of electric railway operation will agree with me that evolution in the direction of electric car gearing will develop remarkable changes in a very short time. Notwithstanding the great ingenuity which has been exhibited in this department of car gearing, and the truck arrangement generally, certain inherent difficulties have developed themselves in this direction which, it is now well recognized, must be eliminated. Taking the gear as the working medium alone, the high speed at which electric motors are operated at the present time is proving very destructive, and from the gear and pinion, each made of cast-iron, we have passed successively through steel, bronze, and other composition mixtures, raw hide and steel and fibre. While each possessed its own particular advantage it was also accompanied by a disadvantage. Thus, for instance, the raw hide and steel pinion very soon developed a trouble, which consisted in the grooving of the meshing gear, which soon made its substitution by a new one absolutely necessary. In this direction alone much can be done, as I have already pointed out.

Again, as the high speeds employed in the motor are, in a great measure, responsible for these troubles, the remedy seems obvious, and is, I believe, already about to be applied in the employment of slower speed motors, and the reduction in the number of steps in the gearing from two pairs to a single pair; in other words, in the reduction of speed from 12 to 1, to something in the neighborhood of 5 to 1. This will probably involve the evolution from the 2-pole motor to a 4, or more, pole motor on the car.

Looking at the question from another standpoint, that of efficiency, or, to put it in plain language, that of the coal pile, I think another illustration of the present conditions can best be shown by alluding to the fact that the results of tests show that nearly 50 per cent. of the energy developed by the steam engine is lost in its various transmutations from the dynamo to the car axle. Placing the loss in the dynamo and in the line at 20 per cent., we have an additional 30 per cent. lost in the motor and the gearing. This excessive amount is one which, I believe, can be considerably reduced, and the remedies suggested have been various. In the first place, there can be no question that the present practice of stopping and starting the motor, by which enormous drafts of current are taken upon starting, can be overcome by a change in the electrical design of the motor and the switching arrangements. On the other hand, it has been suggested that the low efficiency at which the motor operates before it attains its normal speed, can be overcome by an arrangement in which the motor is constantly revolved at its most economical speed, independently of the movement of the car, by providing a suitable gearing by which the motion can be transmitted to the axle. It may be argued that this method may introduce other difficulties, especially in the gearing; but as a principle, pure and simple, it must be admitted to be an idea which is well worth consideration, and which may be developed to good advantage. The other fraction of the 30 per cent. lost between the engine and car axle, is evidently in the gearing itself. It is evident, of course, that every stage in the transmission must involve some loss, but the excessive amount which appears to be lost at present seems certainly capable of diminution. The change from the present high-speed motor, and its double reduction of speed through two pairs of gear with a slow-speed motor and a single pair of gears will, I think, effect a large gain in the direction just pointed out, and we shall probably soon be enabled to judge by experience of the practical value of this arrangement.

As regards the return circuit of the future, whether it shall be overhead, underground, or through the earth, depends largely upon circumstances. In view of the rapid spread of "æstheticism" in this country, notwithstanding the noble lead which your own city has taken on the question of overhead conductors, it seems doubtful whether in many large cities that type of construction can be maintained, and granted that it is, will the present type of construction be continued? It is probable that if it is, it will resolve itself into the system which is already gaining ground rapidly, in which the main feeders will be placed underground, and the working conductors placed upon poles through the centre of the street where double tracks are employed. These poles will not only be available for the suspension of electric railway conductors, but will also serve as supports for the arc and incandescent lights used in the illumination of the streets. As pointed out before, however, the question is one which, in view of the presence of the storage battery, is difficult to discuss, so far as its future aspect is concerned.

But finally, looking generally at the question of the future of electric railroading, and speculating as to its probable extension for traffic other than for street and suburban service, it is proper to consider whether the electric railway will eventually replace the steam engine for trunk lines. While such a change is, of course, by no means impossible, considered from every standpoint, it is probably one which will not come to pass for a long time, if for no other reason than the conservatism of the average railway man. But aside from this aspect of the case, an analysis will, I think, show that there are certain defined limits beyond which electric railroading may not compare with the direct steam locomotive. I have not made a sufficiently close study of this aspect of the case to give any actual figures, and I believe that we shall soon be afforded some definite information on the subject.

But there is still a field for the electric railway beyond mere city traffic, which will, I think, shortly develop into considerable proportions, and that is, in the operation of branch lines to the main steam railway lines, and as connecting links between them. There are many places where such lines, in many cases less than 50 miles in length, could be economically worked on the electric system, and that the advantages afforded are already recognized is evidenced by the fact that the idea is already being put in practice. As an example, I may mention the fact that at Sunbury, Pa., the connecting link between the Lehigh Valley and the Reading Railroads, is an electric railroad, which has contracted to be operated at a speed of 25 miles an hour, and which carries both freight and passengers between the two systems, including in its length the passage through a bridge a mile long. The motor of the electric car is of 30 h. p., and a single one is employed. The advantage of such feeders to main lines is still more apparent when we consider the large distances separating the main lines of railways in the far West, where frequently hundreds of miles intervene between parallel railway lines, and where electric roads might be reticulated..

The probable development of the electric railway might be followed out in a great many more directions, but I think enough has been said to prove that the changes which will take place will be extremely rapid, and that the electric car and the electric railway system generally, of ten years hence, will be quite unlike that of the present day.

I regret very much that the time at my disposal has been insufficient to present a more elaborate and better-digested treatment of the subject, and indeed, what has been said is intended more as the basis for a discussion of the subject, which I hope will be indulged in, than a thorough treatment of the same.

.... MANKIND fails at least a hundred times to one compared with the failure of a mechanical contrivance.—*Sir D. Salomons.*

.... WHEN an experimental fact was obtained by Faraday, it was instantly enlarged by his imagination.—*John Tyndall.*

.... THE public is still so ignorant on electrical matters, that some scheme should be set on foot to enlighten it.—*Sir D. Salomons.*

.... MAKING a good insulated joint in an underground wire that will show high insulation is an art in which few attain perfection, without having had long and constant practice in such work.—*F. C. Allsop.*

.... NOTHING looks so bad as a bundle of wires all twisted and hanging about loosely, and if there has been any slovenly wiring in a house, it will always be found in its most violent form at the indicator.—*F. C. Allsop.*

.... UNLESS electrical work be thoroughly well done and passed by competent persons other than the fire office inspectors, who have often not sufficient practice to understand every detail, the result will not be satisfactory.—*Sir D. Salomons.*

ELECTRICAL RADIATION FROM CONDUCTING SPHERES, AN ELECTRIC EYE, AND A SUGGESTION REGARDING VISION.[1]

BY OLIVER J. LODGE.

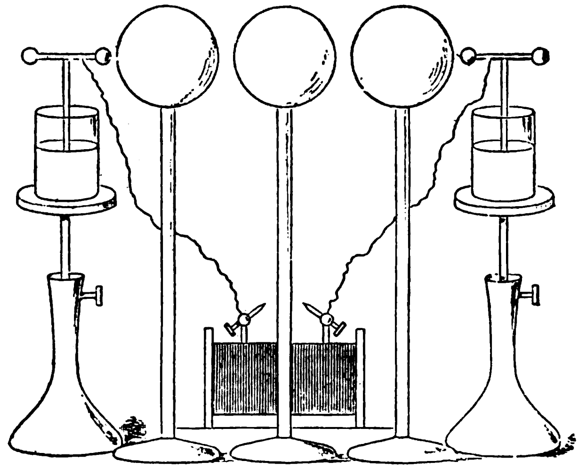
I do not know how far the description of little isolated experiments is serviceable, but I am tempted to communicate a simple plan I use for exciting electric oscillations in dumb-bells, ellipsoids, elliptical plates, spheres, or other conducting bodies of definite geometrical shape unhampered by a bisecting spark-gap. I do it by supplying electricity to opposite ends of the conductor by means of Leyden jar knobs brought near enough to spark to it; said knobs being likewise connected with the terminals of a small Ruhmkorff coil. The charge thus supplied or withdrawn at every spark settles down in the conductor after a few oscillations, and these excite radiation in surrounding space.

There are many ways of arranging the Leyden jars, some more effective than others. The outer coats of the two jars may, or may not, be connected together. Connecting them in some cases brightens the sparks at short range, but seems to have a tendency to weaken them at long ranges. It is not difficult to surmise why this is so.

Of course, when the outer coats are disconnected, only an insignificant portion of the capacity of the jars is utilized; but unless the thing to be charged has too large a capacity it works perfectly well.

The receiver or detector is a precisely similar conductor touched to earth by a point held in the hand. The distance at which such a receiver responds is surprising. Or one may use a pair of similar conductors and let them spark into each other; but this plan is hardly so sensitive, and is more trouble.

The fact of being able in actual practice to get radiation from a sphere, is interesting, inasmuch as the subject of electrical oscillations in a perfectly conducting sphere has been worked out accurately by Professor J. J. Thomson in the London Mathematical Society's Proceedings. I have not the volume by me, but I think he reckons the period of oscillation as the time required by light to travel 1.41 diameters of the sphere.



Experiments in Electric Radiation.

The case of spheres of ordinary metal will not be essentially different, with these rapid oscillations, for the electric currents keep to a mere shell of surface in either case; and in so far as *damping* affects the period, the dissipation of energy by radiation (which is common to both) is far greater than that caused by generation of heat in the skin of a metal sphere.

I happened to have four similar spheres of nickel-plated metal on tall insulating stems; each sphere 12.1 centimetres in diameter. Applying spark knobs to each end of a diameter of one of them, and applying the point of a penknife to another one standing on the same table at a distance of two and a half metres, I am able to get little sparks from it without using any reflector or intensifier.

Or arranging three spheres in a row, with intervals between and knobs outside, 5 short spark-gaps in all (see figure), and using a fourth sphere as a detector of this triple-sourced radiation, I draw little sparks from it to a touching penknife at a distance of 12 feet (366 centimetres, actual measurement.)

In this case it may be a trifle better to hold one's hand near the receiving sphere at the side opposite to the penknife, and thus vary its capacity by trial so as to imitate the disturbing effect of the contiguous spheres in the transmitter.

The complete waves thus experimented on and detected are only 17 centimetres (six and a half inches) long, and I imagine are about the shortest yet dealt with.

But we do not seem near the limit set by lack of absolute suddenness in sparks yet, and are going on to try a large number of little globes.

Exciting a lot of little spheres by a coil in this way forcibly recalls to mind the excitation of a phosphorescent substance by a coil discharge.

And a receiver not very unlike the rod-and-cone structure of the retina can likewise be made. My assistant has been experimenting on a sort of gradated receiver which he made himself. I have recently had made a series of long cylinders with diameters ranging above and below 12 centims.; and the length of each which responds to radiation is a kind of measure of specific intensity. They form (speaking sensationally) an electric eye with a definite range of color sensation. It would be easy to supply it with a pitch or paraffin lens.

There is no need to suppose the retinal bodies to be conducting; a body of high refractive index should be subject to electric vibrations, and its surface to spurious electrifications, when radiation falls upon it; and the optical density of the rods and cones is known to be high. They may, however, be electrolytic conductors; and I find that a liquid sphere—*e. g.* a flask of inky water—responds to radiation, giving a glow to a point touching its glass.

The diameters of the rods, as measured by various physiologists, are not very different from dimensions adapted to respond to actual light-vibration frequency; and if this idea substantiates itself, these bodies can be supposed to constitute a sort of Corti's organ responding to etherial instead of to aërial vibrations, and stimulating in some still unknown, but possibly mechanical, manner, the nerve-fibre and ganglion with which each appears to be associated.

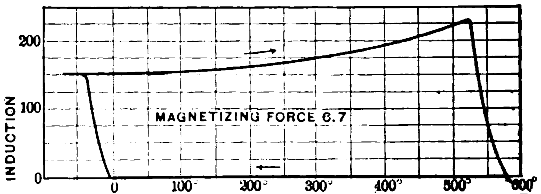
MAGNETISM.

BY DR. JOHN HOPKINSON, F.R.S.

(Continued from p. 248.)

The properties of an alloy of manganese and iron are curious. More curious are those of an alloy of nickel and iron. The alloy of nickel and iron containing 25 per cent. of nickel is non-magnetic as it is sure to come from the manufacturer; that is to say, a substance compounded of two magnetic bodies is non-magnetic. Cool it, however, a little below freezing, and its properties change: it becomes very decidedly magnetic. This is perhaps not so very remarkable; the nickel steel has a low critical temperature—lower than we have observed in any other magnetizable body. But if now the cooled material be allowed to return to the ordinary temperature it is magnetic; if it be heated it is still magnetic, and remains magnetic until a temperature of 580° C. is attained, when it very rapidly becomes non-magnetic, exactly as other magnetic bodies do when they pass their critical temperature. Now cool the alloy: it is non-magnetic, and remains non-magnetic till the temperature has fallen to below freezing. The history of the material is shown in Fig. 11, from which it will be seen that from —20° C. to 580 C. this alloy may exist in either of two states, both quite stable—a magnetic and a non-magnetic—and that the state is determined by whether the alloy has been cooled to —20° C. or heated to 580° C.

Sudden changes occur in other properties of iron at this very critical temperature at which its magnetism disappears. For example, take its electrical resistance. On the curve Fig. 12 is shown the electrical resistance of iron at various temperatures, and also the electrical resistance of copper or other pure metal. Observe the difference. If the iron is heated, its resistance increases with an accelerating velocity, until, when near the critical temperature, the rate of increase is five times as much as the copper; at the critical temperature the rate suddenly changes, and it assumes a value which, as far as experiments have gone, cannot be said to differ very materially from a pure metal. The resistance of manganese steel shows no such change; its temperature coefficient constantly has the value of .0012, which it has at the ordinary temperature of the air. The electrical resistance of nickel varies with temperature in an exactly similar manner. Again, Professor Tait has shown that the thermo-electric properties of iron are very anomalous—that there is a sudden change at



Elect. Engineer, N.Y.

Fig. 11.

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[1] *Nature.*

or about the temperature at which the metal becomes non-magnetic, and that before this temperature is reached the variations of thermo-electric property are quite different from a non-magnetic metal.

Professor Tomlinson has investigated how many other properties of iron depend upon the temperature. But the most significant phenomenon is that indicated by the property of recalescence. Professor Barrett, of Dublin, observed that if a wire of hard steel is heated to a very bright redness, and is then allowed to cool, the wire will cool down till it hardly emits any light at all, and that then it suddenly glows out quite bright again, and afterwards finally cools. This phenomenon is observed with great difficulty in the case of soft iron, and is not observed at all in the case of manganese steel. A fairly approximate numerical measurement may be made in this way: Take a block of iron or steel on which a groove is cut, and in this groove wind a coil of copper wire insulated with asbestos; cover the coil with many layers of asbestos; and finally cover the whole lump of iron or steel with asbestos again. We have now a body which will heat and cool comparatively slowly, and which will lose its heat at a rate very approximately proportional to the difference of temperature between it and the surrounding air. Heat the block to a bright redness, and take it out of the fire and observe the resistance of the copper coil as the temperature falls, due to the cooling of the block. Plot a curve in which the abscissæ are the times, and the ordinates the logarithms, of the increase of resistance of the copper coil above its resistance at the temperature of the room. If the specific heat of the iron were constant, this curve would be a straight line; if at any particular temperature latent heat were liberated, the curve would be horizontal so long as the heat was being liberated. If now a block be made of maganese steel, it is found that the curve is very nearly a straight line, showing that there is no liberation of latent heat at any temperature. If it is made of nickel steel with 25 per cent. of nickel, in its non-magnetic state the result is the same—no sign of liberation of heat. If now the block be made of hard steel, the temperature diminishes at first; then the curve, Fig. 13, which represents the temperature, bends round; the temperature actually rises many degrees whilst the body is losing heat. The liberation of heat being completed, the curve finally descends as a straight line. From inspection of this curve, it is apparent why hard steel exhibits a sudden accession of brightness as it yields up its heat. In the case of soft iron the temperature does not actually rise as the body loses heat, but the curve remains horizontal or nearly horizontal, for a considerable time. This, again, shows why, although a considerable amount of heat is liberated at a temperature corresponding to the horizontal part of the curve, no marked recalescence can be obtained. From curves such as these it is easy to calculate the amount of heat which becomes latent. As the iron passes the critical point it is found to be about 200 times as much heat as is required to raise the temperature of the iron one degree centigrade. From this we get a very good idea of the importance of the phenomenon. When ice is melted and becomes water, the heat absorbed is 80 times the heat required to raise the temperature of the water one degree centigrade, and 160 time the heat required to raise the temperature of the ice by the same amount. The temperature of recalescence has been abundantly identified with the critical temperature of magnetism.[1] I am not aware that anything corresponding with recalescence has been observed in the case of nickel. Experiments have been tried, and gave a negative result; but the sample was impure; and the result may, I think, be distrusted as an indication of what it would be in the case of pure nickel. The most probable explanation in the case of iron, at all events, appears to be that when iron passes from the magnetic to the non-magnetic state, it experiences a change of state of comparable importance with the change from the solid to the liquid state, and that a large quantity of heat is absorbed in the change. There is, then, no need to suppose chemical change; the great physical fact accompanying the absorption of heat is the disappearance of the capacity for magnetism.

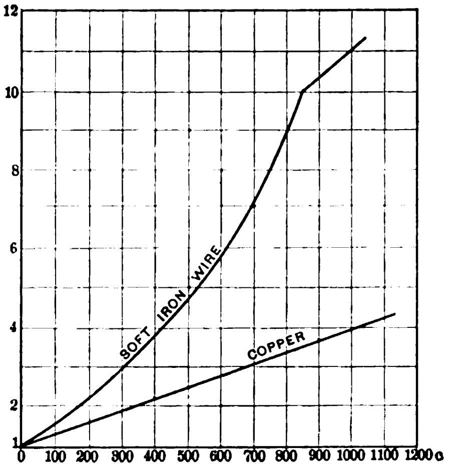

FIG. 12.

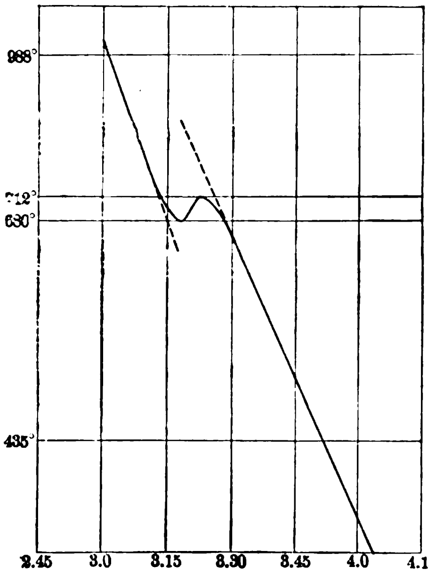

FIG. 13.

(*To be concluded.*)

THE ELECTRICAL SECTION OF THE CENSUS.

PROGRESS OF THE WORK.

THE following schedules have been completed, and a copy is now ready for the printer:

LIST OF SCHEDULES.

1. Manufacturers of electrical apparatus, instruments and supplies.
2. Electric light and power central stations.
3. Fires caused by electric currents. Information to be obtained from electric central station companies.
4. Fatal casualities occuring on electric currents. Information to be obtained from electric central station companies.
5. Fires caused by electric currents. Special investigation in cities of 10,000 population and over.
6. Fatal casualties occuring on electric currents. Special investigation in cities of 10,000 population and over.
7. Isolated electric lighting and power plants.
8. Educational institutions. Electrical engineering courses.

The schedule for central station companies required infinitely more work for its preparation than any other. While in preparation it was shown to a large number of managers of central station companies and others, and full benefit has been taken of every suggestion offered. Every possible effort has been made to render it full, plain, complete and practical. The range of inquiries in the complete schedule necessarily covers all apparatus and service that a central station company may have in use or render.

THE ELECTRICAL SUB-DIVISIONS OF THE SCHEDULE.

1. Underground conduits.
2. Underground conductors.
3. Aerial conductors.
4. Incandescent lamps.
5. Arc lamps.
6. Converters.
7. Accumulators.
8. Meters.
9. Stationary motors.
10. Current supplied to motor cars.

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[1] I have only recently become acquainted with the admirable work of M. Osmond on recalescence. He has examined a great variety of samples of steel, and determined the temperatures at which they give off an exceptional amount of heat. Some of his results are apparent on my own curves, though I had assumed them to be mere errors of observation. For example, referring to my Royal Society Paper, there is, in Fig. 38, a hint of a second small anomalous point a little below the larger one. And comparing Figs. 38 and 38*a* we see that the higher the heating the lower is the point of recalescence; both features are brought out by M. Osmond. The double recalescence observed by M. Osmond in steel with a moderate quantity of carbon, I would explain provisionally by supposing this steel to be a mixture of two kinds which have different critical temperatures. Although M. Osmond's method is admirable for determining the temperature of recalescence, and whether it is a single point or multiple, it is not adapted to determine the quantity of heat liberated, as the small sample used is enclosed in a tube of considerable mass, which cools down at the same time as the sample experimented upon.

To avoid sending a company inquiries that do not pertain to its business, the schedule will be printed in sections. To ascertain what section to send to each company, the following inquiries are being sent out to be answered at once.

1. Do you own or operate underground conduits?
2. Do you operate incandescent lamps?
3. Do you operate arc lamps?
4. Do you operate a converter system?
5. Do you operate an accumulator system?
6. Do you operate stationary electric motors?
7. Do you operate or supply current to electric motor cars?
8. Are you making, or do you contemplate making additions to your plant during the year 1890? If so, please state of what the additions will consist, and give the total amount of estimated cost.

The last question is intended to make "the pigs stand still until they can be counted."

The returns from the preliminary schedules sent out in February and March are quite satisfactory. An official directory of electric central station companies is now being compiled from these schedules, and all other sources of information at command. If any company has failed to return the preliminary schedule, it will oblige the Census Office greatly by doing so at once. In case a company has failed to receive this schedule, one will be forwarded at once if it will kindly give notice of the fact. All companies are earnestly requested to notice carefully the way their names are written on all papers addressed to them, and to make needed corrections in their replies. With such assistance, and due diligence in the Office, a creditable degree of correctness may be attained.

The schedules that have been prepared outline only a portion of the work. To sub-divide the inquiries for Manufacturers, directories are being compiled, classified as follows:

DIRECTORIES OF MANUFACTURERS.

1. Dynamos.
2. Motors.
3. Incandescent lamps.
4. Arc lamps.
5. Carbons.
6. Insulated conductors for electric currents.
7. Conduits.
8. Primary cells.
9. Accumulator cells.
10. Electric meters.
11. Electric clocks.
12. Electric welding apparatus.
13. Electro-plating machines.
14. Electric fire alarms.
15. Electric burglar alarms.
16. Electrical apparatus for use in medicine and surgery.
17. Electrical instruments.

Extended as this list is, it requires many additions to make it complete.

A letter has been addressed to each manufacturer, requesting him to assist in furnishing information for a chapter in the Census report, on the "Manufacture and Uses" of the special apparatus named. This letter solicits:—

1st, A list of all manufacturers of the apparatus.

2d, A list of the addresses of all users of the apparatus when this is practicable, together with a statement of the purposes for which it is being used.

3d, A full description of any novel or special use being made of the apparatus.

4th, Suggestions of pertinent inquiries for a schedule to be sent to manufacturers and also for a schedule to be sent to users of the apparatus when desirable, for the purpose of obtaining information considered to be important.

It is very clear that this invitation affords manufacturers an opportunity to furnish information, the publication of which will be a revelation, not to laymen alone, but to those most familiar with the progress being made in adapting electrical energy to the services of civilized life. Such a publication will vastly increase popular knowledge and appreciation of the advantages and value to be derived from the manifold uses of electricity. It will furnish a solid basis of facts for all arguments. Its impersonal and impartial character will convince the public of its truth. It will set at rest all doubts and fears. Future public action guided by it and dealing with electrical interests will be intelligent and consistent with the people's welfare. A truthful statement showing what electricity is doing, as it will be told in these chapters and others to be formed, will be enormously valuable to the people of this country.

The day is not distant when the economic value of applied electricity will be known to exceed that of the output of all mines of gold and silver; its administrations to health, to be more potent than all other remedies; and when all peoples will be made neighbors and friends by its matchless power to convey intelligence and persons. When that day comes, he who attempts to cast odium upon any form of the apparatus through which electricity manifests its helpful power, or seeks to block its progresssive development by raising false danger signals, will be known and shunned as an enemy to public welfare.

ALLEN R. FOOTE, *Special Agent.*

A NEW ARMINGTON & SIMS TRIPLE EXPANSION ENGINE.

FOUR years ago the Washburn & Moen Manufacturing Co., of Worcester, Mass., contemplated a radical change in their method of drawing steel wire, and proposed the adoption of a triple compound high-speed engine, that should, in fact, be three distinct centre-crank coupled, parallel engines with cranks at 120 degrees. By so locating the cranks, a dead centre was prevented and the engine could be started at any time, as provision was made to admit live steam, simultaneously, to each of three cylinders, so that if the crank of the high-pressure cylinder was on the dead centre, one of the others, and possibly two, would be effective. After starting, steam from the low pressure cylinders was shut off allowing the engine to run as designed and intended.

The amount of power desired was 700 h. p., and with three crank pins, whose relative positions were equally distant upon the circumference of a circle described by their centres, it was evident that the retardation of the crank pin of a long stroke slow-speed engine would be impossible in this case, as absolute uniform speed would have to be obtained. The requirements of such an engine would be very severe indeed, as the train of rolls would be directly connected by a rigid coupling to the shaft of the engine. Its load under 120 pounds pressure would at times be only the amount of power required to overcome the friction of the engine and rolls. Instantly it would be 700 h. p., as the steel bloom entered the first pair of rolls, and, after leaving, the automatic cut-off would control the speed with a variation of two per cent.

An offer to build this compound engine was made to the Armington & Sims Engine Co., Providence, R. I., but they being pressed with orders, kindly permitted the use of all of their inventions, together with models and drawings, for a nominal royalty, the engines being built elsewhere.

The Washburn & Moen Manufacturing Co. are pushing another new mill rapidly towards completion and have placed their order with the Armington & Sims Engine Co. for a compound engine of 1,000 h. p., to run from 200 to 250 revolutions per minute, having a piston speed of from 800 to 1,000 feet. Although 1,000 h. p. will be taken from one end of the shaft of this engine, the arrangement is such that 500 h. p. can be taken from each end. The automatic regulator is simple, easy of access, and entirely independent of the engine shafts, which are duplicates of each other. The same may be said of all of the parts of these engines which are interchangeable. The weight of the engines without pulleys or foundation boxes is 180,000 pounds.

The Ferranti electric light station at Deptford, London, has engines of 1,250 h. p. Their height above the floor is 43 feet, while that of the Washburn & Moen Manufacturing Co. is but five feet; length, 17½ feet; width, 16⅛ feet; or about 0.28 square foot of floor surface for 1-h. p. In large cities where real estate is very valuable and is an important consideration to the shareholder, it would be well for electric light and power interests, to think seriously of advancing another step which seems practical, in the direction thus indicated above.

Messrs. Armington & Sims have also in hand several special engines directly connected to dynamos, for foreign governments as well as our own navy department, and merchant marine. The dynamos are furnished by the Thomson-Houston, Edison, Brush and Wenstrom companies. This is but a return to the original plan of Mr. Edison with his first "Jumbo" dynamo and the Armington & Sims engine that was sent to the Paris Electrical Exhibition, in July, 1881. This combination is still doing good daily service. It should some day be brought back to this country and placed in the National Museum at Washington, as it was the first successful combination ever constructed, and should be preserved. Students will readily realize the progress and development of engines and dynamos during the past 10 years, and this, the latest departure, is well worthy of attention. If we are not mistaken, there is already a marked tendency in the direction indicated, so that with the larger engines we shall see slower speed dynamos of the multipolar type.

THE SALOMONS ELECTRICAL ENGINEERING SCHOLARSHIP.

Sir David Salomons has offered to devote £1,000 ($5,000) to the foundation of an electrical engineering scholarship. This will furnish a scholarship of £30 or £40 ($150 or $200) a year. The management of the matter is left in the hands of a committee of the Council of the Institution of Electrical Engineers.

.... THERE is one point connected with gas engines which most people overlook, and it is a very important one—the fuel is carried to the spot free of expense and without trouble at all times and in all weathers.—*Sir D. Salomons.*

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Lenox Lyceum Electrical Exhibition.—Lecture by Dr. S. S. Wheeler.—The Electrical Execution Chair.—Investigating Electric Traction and Gas Leaks.—Electric Traction Developments.—A Reception at the Brooklyn Edison Station.—City Electric Lighting Contracts.

THE management of the Electrical Exhibition in aid of the New York Exchange for Women's Work has devised a new feature for the show at the Lenox Lyceum. It is called "A Glimpse of the Twentieth Century," and is a comedy suggested by Bellamy's "Looking Backward." There are but two characters in the play, one of whom is a person who wakes in 1999 after a sleep of 104 years. He is then confronted with a twentieth century gentleman, and they converse together on the wonderful strides of arts and sciences that have been made during the century. The fun is confined to local hits, some of which are very good. Electrical effects are introduced. It may be mentioned that Mr. George H. Guy, the energetic secretary of the New York Electrical Society, who has provided so many pleasant and profitable meetings this season, has arranged for a special evening, on Friday, April 25, when tickets will be issued at half price to members of the Society, or of the New York Electric Club and the American Institute of Electrical Engineers. As ladies are particularly invited on this occasion, the attendance will doubtless be very large. Mr. Guy's address is 127 Temple Court, this city.

Last Friday, April 18, Dr. S. S. Wheeler delivered a lecture before the Y. M. C. A. in Harlem on the "Practical Uses of Electricity." The lecture was illustrated by experiments, and wires were run into the building for the occasion. The lecture brought a large audience together, and was greatly enjoyed.

The New York papers are agog about the execution of Kemmler next week. With regard to the "chair of death," a *Herald* reporter says: "It is not the clumsy piece of furniture, as you can plainly see, designed by that alleged electrical expert and newsmonger on the sly, Mr. Harold P. Brown. That piece of barbarity, with its helmet of fire and its glass footrests for naked feet, will go into innocuous desuetude before this simple and scientific contrivance, which, if electricity can be made merciful, ought to make it so. It will at least not torture the condemned man before it kills him. The latest form of chair—I cannot learn the name of the inventor, but I half suspect the Warden has had much to do with constructing it—is a comfortable chair with an upright back, and arms that are adjustable to those of the man that sits in it. There is a leather covered pillow for the head to rest against. Fastened to the back is an adjustable figure 4 which can be raised or lowered so as to come down over the head of the condemned. The technique of the thing is very simple. Through the lower outer angle of the 4 there is a hole, and through this will pass a rubber tube containing a rod of steel or copper, to which a wet sponge is fastened. This sponge will touch the crown of the condemned man's head. Another pipe, with webbing inside and a sponge, will pass up through the seat so as to touch the base of the spine, when the man is strapped firmly in his seat. This will be accomplished by the use of several straps, one passing around the chest, another around the abdomen, which will draw the webbing against the spine, while the arms will be firmly strapped to those of the chair on which they will rest. The feet will rest on a comfortable foot-rest, after the fashion of those in use in a barber shop. The current will be generated by a dynamo which has been placed near to the power room, a thousand feet away from the place of execution, and the insulated wires which will connect it with the rods and sponges have all been strung in readiness for their work."

The Senate Committee, now in this city investigating electrical matters have taken a glance at electric traction, and last week had Frank J. Sprague before them. They were treated to a clear, incisive sparkling talk, such as only Mr. Sprague can give, and will not now be able to say that they are not well and authoritatively informed on the subject. They also had before them Stephen McCormick, the Superintendent of the Bureau of Lamps and Gas in the Department of Public Works, who said that he had studied the subject of gas leakage for 14 years. When the gas mains were first laid they had been properly constructed, but Mr. McCormick thought that they had been weakened by the excavations that had been made all around them. The construction of subways was accountable for some of the leakage, as in many places the workmen had laid bare the pipes and had been careless in working around them. The average leakage of gas in this city was about 10 per cent., and no city authority had any control over the gas companies. All that the Department of Public Works could do in case of leakage was to inform the gas companies. As a rule, these companies were anxious to repair all leaks, but Mr. McCormick thought that the Commissioner of Public Works should have the authority to control them. In some of the avenues in New York there are six different gas mains, and on Manhattan Island there are 1,423 miles of gas mains owned by seven different companies. As to the pipes, Mr. McCormick said that those of wrought-iron made better joints, but they would not last as long as cast-iron pipes. Now that the electric wires were being put under ground, the question of gas leakage was becoming a serious one. Many deaths from gas in private houses, Mr. McCormick thought, were due to the lack of stops on the gas cocks, and inspectors of the Board of Health should look after these matters.

The reports as to the entry of the Westinghouse company into the electric railway field have excited general interest, especially as they are now confirmed. Another item in the same line is the report of an understanding arrived at between some of the other "independent" electric traction companies, from which interesting developments may soon be expected. The magnitude of the work to be done in this department is evidently attracting the attention of capital.

The Edison station in Brooklyn, which has already been described in THE ELECTRICAL ENGINEER, was the scene of a reception on April 8 and 10, when a large number of visitors inspected the arrangements and details of the handsome plant, as well as the Bergmann Co.'s showroom, the Perret motors running the workshop, the Sprague electric swing hoist, the new Ward, Kinsman and Universal arc lamps, and other special features. At the close of the reception on April 8, Mr. Edison, Mr. Hastings and others spent an hour at the Hamilton Club, in social enjoyment with its members, who valued highly this opportunity of meeting Mr. Edison face to face.

With regard to the city contracts for electric lighting, the *Sun* quotes Mr. Paul D. Cravath, as follows:—"Representatives of the electric light companies whose bids for lighting the city the Gas Commission considered so high that it refused to accept them, were unanimous yesterday in declaring that their various corporations would not have made anything if the bids had been accepted. They were also unanimous in saying that the cost of electric lighting in New York, even at the advance of four cents a lamp a night, would be less than in any other large city. The views of all are expressed with particular emphasis by Paul D. Cravath, counsel for the United States Illuminating Co. and the Brush Electric Illuminating Co., which together supply about 600 of the 1,000 lights used by the city. Mr. Cravath said that the price of 35 cents a lamp a night was originally agreed to by the different companies because, on account of the smallness of the appropriation, the city couldn't pay any more. The use of the subways, however, caused increased expenditure, so the United States and Brush had to raise their rates this year to an average of about 40 cents a lamp, the other companies doing the same. Nevertheless, continued Mr. Cravath, there was not a single company which would come out whole on the city lighting if the contracts were awarded to them at the prices named in the bids, and the companies would, if anything, be the gainers if the city give up the use of electric lights and returned to the use of gas, as it apparently proposes to do. At the prices named in the recent bids New York would be furnished with electric lights at much cheaper rates than in any other large city. According to Mr. Cravath, the price in Philadelphia is more than 50 cents a lamp a night, in Boston 55, in Brooklyn 50, in Washington 60 cents. In conclusion Mr. Cravath denied that there was any combination between the companies."

NEW YORK, April 18, 1890.

PHILADELPHIA.

Complaints of Telephone Service.—Western Union and the Telephone Conduits.—The Cope Underground Wiring System.—New Underground Lighting Service.

IN view of the many complaints made of poor service furnished by the Bell Telephone Co., the directors of the company held a meeting a few days ago, and authorized rebates for such time as 'phones are out of order. Dr. Plush, Superintendent of the local telephone company, said that the company would be glad to have all the business exchanges of the city appoint a careful conference committee to compare the telephone service in Philadelphia with that in other cities. He added that it would be an interminable work to introduce in this city the metallic circuit system.

The Electrical Committee of Councils has reported a bill to permit the Western Union Telegraph Co. to make connections with the underground conduits of the Bell Telephone Co. The Western Union company wanted to carry its wires from Third and Chestnut streets to Fifth and Market, and as Councils refused to grant the necessary authority the company appealed to the United States District Court, asking for an injunction to restrain the city authorities from interfering with the erection of its poles on the streets named. The Electrical Committee of Councils held an executive session last week, which was attended by City Solicitor Warwick, to consider the dispute. Mr. Warwick recommended the passage of an ordinance granting the Western Union company authority to connect with the conduits of the Bell Telephone Co. He intimated that if this ordinance should be passed the city would be in a position to successfully oppose the averment of the Western Union company, and this would, perhaps, save the Court from rendering a decision against the city. Chairman Graham, of the Electrical Committee, secured the signatures of thirteen members to the report. The matter will come up at the next meeting of Councils.

A number of persons interested in electric light, telephone and telegraph companies recently witnessed a test of a new method of running electric cables through underground conduits. The idea is based upon the principle employed in the pneumatic package and message delivery system. The plan now in general use is to have a number of small tubes that may be screwed together and by attaching these one to another as they are forced through the conduit a continuous tube is formed, and with the conductor fastened to the end of this it is drawn through, small sections at a time. This method is very laborious, and it is said requires two hours to run a cable through a square of street. The Cope system, which employs the pneumatic contrivance, shot a conductor through the Bell telephone conduit on Market street, between Second and Third streets, a distance of about four hundred feet, in three minutes. The cable was attached to a plug and was run off from a reel, inclosed in an air-tight case, and through a section of pipe connected with an air-pressure pump. The operation of the pump forced the plug through to the next man-hole at the end of the square and the attached cable, of course, went with it.

Councils Electrical Committee decided to report favorably an ordinance permitting the Columbia Electric Light Co. to lay and maintain underground conduits, cables and wires for incandescent electric lighting on Columbia avenue, from Broad to Twenty-third street; west side of Broad, from Columbia avenue to Master street; Fifteenth street, Sixteenth, Seventeenth, Eighteenth, Nineteenth and Twentieth streets, from Montgomery avenue to Master street.

PHILADELPHIA, April 18, 1890.

ST. LOUIS.

Electric Railway Work.—The Union Depot Railroad Power House.

SEVEN electric railroad bills have been signed by the mayor. The list includes the Benton-Bellefountaine, the Forest Park, Laclede and Fourth street, the Lindell, the Mound City, the Missouri, the Union Depot and the Vandeventer Avenue Railroad Co., a new cross-town road, which will be used as a feeder for the Lindell and the Missouri companies. The mayor also signed the St. Louis Railroad bill, which authorizes cabling of the main line and the use of storage batteries or overhead wire on the Seventh street section. A contract for 7⅓ miles of double track cable was closed yesterday, so this puts a quietus on electric power for the main line, as was conjectured last week.

The ordinances of the Forest Park, Laclede and Fourth street, the Missouri and the Lindell authorize the use of storage batteries or overhead wires. The Benton-Bellefountaine, the Mound City and the Union Depot are authorized to use overhead wires only while the new Vandeventer Avenue road is authorized to use overhead wires or cables. Speed is regulated to 10 miles per hour in the down-town district, and 12 and 15 miles per hour outside of this district. The Missouri and the Forest Park, Laclede and Fourth street companies are anthorized to extend their tracks into Forest Park and to erect jointly a $25,000 passenger depot.

The Lindell Railway Co. have let a contract to Rhoan Bros., of this city, for boilers of about 1,600 h. p. capacity, to cost some $24,000. A contract for Armington & Sims compound engines and a $25,000 passenger depot in Forest Park has also been closed.

The Union Depot Railroad power house car sheds and electrical equipment are approaching completion. A trial run was made last Saturday. The installation consists of three Heine patent safety boilers of 150 h. p. each, and two Hamilton-Corliss engines of 325 and 230 h. p. respectively. The countershafting, 96 feet long and 8 inches in diameter, fitted with Hill patent clutches, was furnished by the Eclipse Wind Engine Co., of Beloit, Wis. Rope transmission is used in transmitting power from the countershaft to dynamos. At present six of the latest improved 80 h. p. Thomson-Houston generators are in position, and two more will be added shortly. The wiring and switch-board fitting was carried out by Mr. Edward Verstraete, electrician. The switch-board, 16 x 12, of solid cherry, was built by the St. Louis Car Co., after special designs by Mr. Verstraete, is an elegant piece of workmanship, both electrical and mechanical, and a credit to both parties. Six motor cars are now on hand, and others will be fitted as fast as the car company can supply the cars, until the entire number—30—are fitted up. Reconstruction and wiring of track and the erection of overhead wires in the down-town district will be pushed to completion with all possible haste.

The stockholders of the Southern Railway Co. will hold a meeting May 5 for the purpose of voting upon a proposition to increase the capital stock from $200,000 to $500,000, and to authorize an increase of the bonded indebtedness to $500,000, the object of which is to change to electric power by overhead wire. Plans of their poles and overhead structure have been submitted to the Board of Public Improvements.

ST. LOUIS, April 18, 1890.

BOSTON.

The New Telephone Exchange.—The New England Electric Exchange. Thomson-Houston Annual Meeting.—New Offices of the Boston Fire Underwriters' Union.—Long Distance Telephoning.—Extension of Welding Applications.—Control of Electric Wires.—The Speed of Electric Railway Cars.—Meetings of the Electric Club.

THE new Telephone Exchange building, now in course of construction on State street, Boston, is to be fitted throughout with a complete system of incandescent electric lighting. This is one of the largest office buildings in the country, and the occupants will depend entirely upon electric light for artificial illumination, as no gas is to be introduced into the building. The contract for the wiring and appurtenances has recently been awarded to the New England Wiring and Construction Co., of Boston, the oldest house in this line of business in New England. The Interior Conduit system will be used throughout for the wiring, and all the latest and best methods in this class of work will be pursued in this building. Many features new to incandescent wiring will be introduced, and it is the intention to make this one of the most complete plants in the country. This is the largest contract for work of this character which has been awarded in New England, and the largest, with two or three exceptions, in the country. The building will be wired for about 5,000 16 c. p. lamps.

The annual meeting of the New England Electric Exchange was held in the rooms of the Boston Electric Club on Monday, when the annual report of the treasurer was read and accepted, and new officers for the ensuing year elected. Mr. P. H. Alexander, the retiring president, occupied the chair, and in his annual address he traced the growth of the Exchange from its birth two years ago, and alluded to the good work it had done. As the treasurer's report shows, the financial success of the enterprise is complete. When the Exchange started business the insurance and electrical interests were antagonistic. Now they are working in the greatest harmony, and as a proof of that, he said that the insurance companies were entertaining the idea of discontinuing inspections of electric light plants, owing to the greater confidence they have in the good quality of the work done. Mr. H. B. Cram, then read the treasurer's report, and afterwards gave the following license statement:

LICENSE STATEMENT. APRIL 14, 1890.

Class.	Applied.	Granted.	Rejected.	Examined but not reported.	Not examined.
1	84	34	1	2	10
2	120	69	4	3	13
3	34	27	4	2	5
3 B		8			
4	40	70	1	2	6
5	59	69	2	3	14
Not given.	17		4		
	354	277	16	12	48

Total number of applications	354		
Second examination granted without second application	3	357	
Applications withdrawn	2		
Applicants deceased	2	4	353

Total number of licenses granted and certificates issued	277	
Total number of applications rejected	16	
Total number of applicants examined but not finally reported	12	
Total number of applicants not examined	48	353

SECOND APPLICATIONS.

Class.	Applied.	Granted.	Rejected.	Examined but not reported.
1	3	1	1	
2	10	6		
3	2	2		
3 B		1		
4	1	5		1
5				
Not given.	1			
	17	15	1	1

One applicant has made three applications: The first was for third class and a fourth class license was granted; the second was for second class, and an extended fourth class license was granted; the third was for second class, and a second class license was granted.

Received license of higher class than applied for	6	
" " " lower " " " "	118	
" " " the class applied for	143	
" " when no class was named in application	10	277

Of the 16 applicants rejected 1 applied for 1st class.
4 " " 2d "
4 " " 3d "
1 " " 4th "
2 " " 5th "
4 " without naming class.

Applications for extension of license		67
Applications for extension not acted upon	3	
Licenses renewed for one year	64	67

Licenses expired 78
Of which .... 2 have applied for renewal and the
76 applications are awaiting action.

Of the 76 licenses which have expired: 7 applied a second time and have licenses now in force; 1 applied a third time and has license now in force; 2 applied a second time and the second licenses have expired; 1 applied the second time and the second license has been extended.

The following gentleman were then elected as officers for the following year: Mr. Alex. P. Wright, president; Mr. H. H. Fairbanks, secretary and treasurer, and Messrs. W. S. Hill, E. H. Hewins, and H. C. Spaulding, directors. Mr. S. E. Barton, then paid a high tribute to the past good work of the Exchange, and drew attention to the fact that, according to the secretary's statement, there was a licensed man for each electric light station in New England. Mr. E. C. North, the newly appointed chairman of the electric light committee of the New England Insurance Exchange, then spoke of the fact that to-day his friends did not feel the anxiety about the fire hazards of electric wires they once felt, because of the improved methods of work induced by the action of the New England Electric Exchange. He said that a notice should be at once sent out to every electric company in New England allowing thirty days within which to join the Electric Exchange, failing which, a new inspector might be appointed and an assessment levied on such companies to defray the expenses of such inspection. Thereafter he would do all in his power to take off such assessment. Captain Brophy then spoke a few words in praise of the excellent work done by the Exchange. Mr. Cram then moved "that the board of directors be given full discretion to modify or change the plan of license of the New England Electric Exchange," to provide for the possible discontinuation of inspection by the insurance people. The motion was carried.

A motion was also passed that $200 be paid to the secretary as a partial acknowledgement of his services. The motion was unanimously carried. A vote of thanks was then passed in favor of the retiring officers, which was suitably acknowledged. Mr. Wright will enter upon his duties as president at once, and as he is known to be a hard and assiduous worker, the future success of the Exchange is assured. Mr. Fairbanks is also a general favorite, and has a host of friends in New England who will doubtless give him a cordial reception and warm backing in his new field.

The annual meeting of the stockholders of the Thomson-Houston Electric Co. was held at Middletown, Conn., at which more than three-fourths of the stock of the company was represented. The report of the treasurer was read and accepted. The following named gentlemen were elected directors for the ensuing year: H. A. Pevear, C. A. Coffin, B. F. Spinney, C. H. Newhall, E. Thomson, S. A. Barton, J. N. Smith.

Mr. F. E. Cabot has been appointed as Mr. Killecutt's successor, as chief inspector of the Boston Fire Underwriters' Union. The duties are not new to Mr. Cabot, as he has assisted Mr. Killecutt for some time.

Mr. E. C. North has been appointed as successor to Mr. S. E. Barton, as chairman of the electric light committee of the New England Insurance Exchange. Mr. North's experience with insurance matters is an extensive one, and he now represents in Boston the Merchants' Insurance Company of Newark, N. J. Mr. North appeared last Monday at the annual meeting of the New England Electric Exchange, and said a few words about the proposed work of the Exchange from an insurance point of view, and made an excellent impression in the members present, as an advocate for good electric construction work.

The Long Distance Telephone Company gave an interesting exhibition this week of the extreme accuracy and delicacy of their instruments, by putting their line in connection with their instruments in the Lenox Lyceum, New York City. In that building they have run wires from the Casino, and the notes of the fair Lilian Russell can now be distinctly heard in Boston by those who care to pay about $1.50 for five minutes' use of the 'phone. Among those who have availed themselves of the opportunity is Mayor Hart, who heard the music at his residence on Commonwealth Avenue.

Commodore Farquhar of the United States navy has been inspecting the Thomson electric welding process with a view to determining the advantages of combining lighting and welding in the various navy yards.

Experiments have been made in the Thomson Welding Company's factory at Lynn, with alternating dynamos, having converters for incandescent lamps and welding machines, all on the same circuit. Even when the current is suddenly turned on to make a heavy weld, the lamps were not noticed to reduce in candle power, a momentary flicker being all that was discernible. The experiments go to show that undoubtedly welding and lighting can easily be operated on the same circuit. This opens a large field for welding machines, which can be placed in almost any store for welding purposes, and operated by passing electric currents.

The committee on mercantile affairs continued its hearing on the control of the electric wires, the time being given to the remonstrants.

Arthur Lord appeared as counsel for the Western Union Co., F. A. Wyman for the Westinghouse Co., G. A. Bruce for the Bell Telephone Co., E. W. Burdett for the Electric Light Association, and W. W. Gooch for the Edison Local Co. Prentiss Cummings, counsel for the West End Co., had no objection to the tagging of wires, but would want an opportunity to examine any bills which might be offered to the committee. Mr. S. L. Powers for New England Telegraph and Telephone Co., presented a bill to compel the working of every wire in a public street in Boston and to empower the removal of any unworked wire after October 1, 1890. City Solicitor Bailey of Boston offered a bill providing for a thorough inspection of all electric wires and for the removal of all which are deemed to be unsafe. It requires the owners of wires to see that they are thoroughly put up and protected, and compels them to be tagged once in every 100 feet with a tag showing the owner and electric capacity of the wire. It covers all wires, whether electric or not, and applies to all parts of the State.

The Street Railway Committee has ended the series of elevated railroad hearings, and the outcome is now looked forward to with interest by all. A decision is expected within the next ten days.

The board of aldermen gave a public hearing this week for the general expression of sentiment on the speed of the electric cars. A great deal of dissatisfaction has arisen as to the slow speed, and there were quite a number of prominent business men who appeared in favor of granting an increased rate of speed. As the speed stands to-day electric cars are undoubtedly of little use to the great working public as a means of rapid transit from their homes in the suburbs to the centre of the city. There were a few remonstrants to the granting of an increased rate of speed, but they were sadly in the minority, and it is a foregone conclusion, that the speed will be increased.

Boston, April 19, 1890.

CHICAGO.

Electro-Thermic Manufacture of Watch Springs—A City Lighting Department—Death of Mr. H. A. Glasier.—Lecture by P. Atkinson.

Messrs. Fred. Purdy and Harry Procemier, of Oak Park, one of Chicago's suburbs, have recently perfected a method of tempering watch springs by electricity. After two years of hard and unremitting experiments, and an expenditure of upwards of $25,000, this process is now thoroughly successful. In watch springs manufactured by the old methods numerous troubles existed by reason of the variations of hardness and in thickness entailed thereby. It was impossible to roll a ribbon of steel without variations, up to half of 1,000ths of an inch. By the new electric method these difficulties have been completely overcome. The machinery for manufacturing these springs is automatic, and the hardening is rendered uniform and controlled as desired. It is claimed that a watch spring made by this electro-thermic process possesses an elasticity five to ten per cent. greater than one produced by the ordinary methods of tempering, and by its means a spring is obtained of equal strength and proportionately thinner and having a graduated temper heretofore unattainable, the inner end being made soft and becoming gradually harder as the outer end is reached, whereby the liability to breakage is greatly reduced. The American Spring Company are manufacturing these springs, which, on account of their many points of excellence, will undoubtedly meet with widespread adoption.

Owing to the great increase in the city lighting by the wide employment of the arc light a separate lighting department is now being organized by the city authorities, which will embrace electric lighting, gas and oil. This action has been rendered imperative on account of the continually growing business of this branch of city affairs. Professor Barrett and the present street commissioners, will be the commissioners of this new department, which will be in shape by the first of next month.

It is with deep regret we note this week the sudden death of Mr. H. A. Glasier, the western representative of the J. A. Grant Engine Co., and a member of the Chicago Electric Club, which occurred in the early morning of April 15. Mr. Glasier was not feeling well the afternoon before and returned to his home. His death was occasioned by heart disease. He was a man esteemed and liked by all his acquaintances, and a member whom the club will deeply miss.

Philip Atkinson, Ph. D., delivered the third of his course of four lectures on electricity at the Chicago Athenæum last week. The subject for the evening was "The Storage Battery." The lectures are arranged especially for the benefit of pupils of the Mechanics' Institute and are free to all. A large audience listened attentively to D. Atkinson.

Chicago, April 19, 1890.

PITTSBURGH.

Increasing the East End Plant.—Westinghouse Electric Railway Work.—A City Electrician.—Electric Cars for Funerals.

The East End Electric Light Company of this city is about to double its capacity to meet the increased demand for electric light in Pittsburgh. A number of the outer wards and suburban towns are this time to be covered with electric light. Mr. A. T. Rowand, the president of the company, has purchased a four-acre lot in the Twenty-third ward of the city, on which site the power-house is to be erected. This will be used to supply both arc and incandescent lamps, which will light up Marion, Hazelwood, Glenwood, Homestead, Hays Station and Munhall along the Monongahela river. Another central station plant is to be erected at Sharpsburg for the purpose of supplying light to that borough as well as Etna, Willow Grove, Millvaleborough and other smaller places along the Allegheny river. This company uses the Westinghouse alternating current system of arc and incandescent lighting, and the plant in the East End has now a capacity of 800 arc and 20,000 incandescent lamps. When the proposed extensions are completed the various stations will be in shape to furnish about 40,000 incandescent lights and 2,000 arc lights. Work on this big improvement will be started at once and pushed until all the places mentioned are connected with the system. In this connection it might be mentioned that Pittsburgh has at present more electric lights in use, proportionately speaking, than any other city in the country. The cost of these extensions of service will be quite large, but the company is determined to give its patrons first-class service regardless of expense.

The Westinghouse Electric Company is about to enter another field of electrical construction, which will necessitate the enlargement of the company's plant to a considerable extent. The company has just concluded the arrangements to commence the manufacture of street car motors and such other appliances incidental to the construction of electric street railway work. The motor department has already been set to work to its fullest capacity, and work is turned out day and night. Whether, however, this branch of the business will be definitely carried on in Pittsburgh, or whether a special shop is to be erected in Wilmerding has not yet been decided. There is no doubt that this will open a very large avenue for increased business to the company.

The Birmingham Traction Company has now definitely decided to introduce an electric system on its street car line. This may be considered a victory for electricity, because for a long time it was said that the company intended to make a cable road out of its line. Work on the changing of the track has already been started and the cars are to be running by next October.

The Allegheny police committee met a few nights ago and elected an electrician to take charge of the wires of the patrol service, a duty that will require all of his time for some months. Ever since the work has been given up by Chief Jones, of the fire department, the wires have been wholly unreliable. Lately they have become worse than ever, and when an officer makes an arrest now he takes his prisoner to the nearest telephone and calls for a patrol wagon through the mayor's office instead of calling from a patrol box. At the meeting last night, Mayor Pearson called the attention of the committee to the matter, and handed in a number of applications from persons desirous of being appointed to look after the wires. The matter was not unfamiliar to the committee and they united on the name of H. E. Dillon, an electrician of 10 years experience, who had a number of letters of recommendation. He will be considered a police officer, with the same pay, but will only be required to look after the patrol telegraph wires.

The New Brighton and Beaver Railway Co. and the Beaver Valley Street Railway Co. have consolidated. They will now build an electric road and extend their line to Beaver, a distance of seven miles.

The teamsters of Pittsburgh and Allegheny and the motor men of the Pleasant Valley Street car line are just now at daggers drawn. The former claim that the motor men run their cars too fast, and will not give the teamster a chance to get his vehicle out of the way.

Pittsburgh is, perhaps, the only city in the Union that can boast of the distinction of having electric cars used as funeral carriages. But such is really the case. The Suburban Electric Railway Co. of the Southside, which passes several cemeteries, has adopted this custom, and is now putting its regular chartered cars at the disposal of funerals.

All the machinery for the new apparatus for the city bureau of electricity is to be shipped this month, and Mr. Morris Mead, the city electrician expects to have the apparatus in operation in the fall.

Zanesville, O., is the latest convert to electricity. The Zanesville Electric Street Railway Co. has been incorporated with a capital of $50,000.

Pittsburgh, April 18, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed Editor of The Electrical Engineer, 150 *Broadway, New York city.*

ELECTRIC TRAMWAY DATA.

[123.]—I notice an error in the printing of my paper in your last week's issue; on page 239, "Central Station Cost, Maintenance, Carmen=" Cost" per car mile,"—should be "Central Station Cost, plus Maintenance, plus Carmen—" Cost per car mile." Moreover the sentence immediately following should have been omitted from, "The carmen" * * to "very small."

A word, too, seems necessary as to the apparent inconsistency shown in columns 4 and 5 of table I.; taken together they indicate an efficiency of about 125 per cent.

The data is given just as it came without any attempt to reconcile such obvious inconsistencies. The friction card which is deducted from the average indicated horse-power is undoubtedly too high, for it includes the current for all lamps burning in offices, car house, power house, etc. The friction cards were taken the last thing at night when lights were all burning; but many of these lights burn all day and are taken into account in station electrical readings, whereas in mechanical readings this power for lights is deducted; *i. e.*, the electrical and mechanical power, taking columns 4 and 5, is not for the same load; both the addition of "lights" to the electrical power and deduction from mechanical power cause the ratio to be in error in the same direction. In tests made as these were, by one man without skillful assistance, and with only such facilities as the local companies could afford, no very great accuracy is to be expected. Lamps could not all be put out during the day, nor could a friction card be taken excluding all lamps; in other words, the entire routine of the station could not be subordinated to these tests.

CARY T. HUTCHINSON.

New York City.

NEWS AND NOTES.

COLLEGE NOTES.

Columbia College.

The new building which was erected for the accommodation of the Electrical School has now been fitted up specially for the purpose and contains a number of interesting features. The facilities for obtaining electric current of different kinds and in large quantities are particularly satisfactory. Continuous current to the amount of one hundred amperes, under pressure of either one hundred and ten or two hundred and twenty volts, may be had at numerous points in all the rooms from a specially installed circuit of the three-wire system connected with the 39th street Edison Station. Available at adjacent points and parallel to this circuit is another special circuit of equal capacity on the two-wire system coming from the Edison dynamos of four hundred lights total capacity placed in the cellar. A third special circuit also of one hundred amperes capacity has been put in to connect dynamos, motors, etc., in the electrical workshop, down stairs, with measuring instruments in the upper laboratory, which is devoted to delicate work. A storage battery circuit available at convenient points in the various rooms is to supply current under an E. M. F. of a few volts for testing purposes, galvanometer work, electrolysis and the many other duties which are generally performed in the laboratory by a number of separate primary batteries and their attendant inconveniences. The buildings are lighted entirely by electricity from the regular circuits. Gas for heating and other purposes may be had, wherever needed, from pipes fitted around the walls of each room, just below the ceiling.

The connection with the Edison Central Station is of great convenience as current can be obtained and experiments carried on continuously without regard to the usual noon and evening stopping of machinery, which is such a scource of annoyance in this work. In one particular case a current was used with absolutely no interruption night and day for almost a week. The connection with the Manhattan company's alternating circuit has lately been cut off by the city authorities, but alternating current and arc light dynamos are soon to be put in in order to avoid this unpleasant contingency. To avoid as much as possible any jarring, the tables for the support of instruments have no connection with the floor, but are fastened directly to the brick walls.

The course of instruction may be divided into two branches, the practical and the theoretical. As so much of the progress that has been made in electrical science has been due to theoretical considerations, and as everything points to the fact that the electrical engineer of the future must be a theoretical as well as a practical man, the study of mathematical physics and the theory of electricity has been introduced as a necessary part.

The first session of the first year in the practical course is given up to the study of the fundamental principles of electricity which deserve more attention than they generally receive. In the theoretical branches of the subject are studied, the theory of electric potential, electrostatic distribution and induction, theory of the condenser, dielectric polarization, etc. The theory of electrical measurements starts with the principles of the conservation of energy, Joule's law, etc., and then passes to the construction, performance and use of electrical measuring apparatus of all descriptions. Transmission dynamometers and the methods of mechanical measurement are also treated. Co-ordinate with this theoretical instruction, the entire afternoon of each day is spent in practical laboratory work in electric measuring and testing.

In the second session the work is more advanced. On the practical side the construction and operation of dynamos and motors are studied carefully and minutely; also arc and incandescent lamps, telegraphs, telephones, primary and secondary batteries, etc. In the mathematical theory the students take up the study of the laws governing constant electric flow in linear conductors, theory of thermo-electricity, magnetism, electro-magnetic induction, Maxwells's dynamical theory of the electro-magnetic field, etc. The instruction in the theory of the dynamo and motor includes the characteristic and current curves of the different types of machines, construction and use of diagrams in practical work, determination of the different efficiencies, the theory of constant potential and constant current machines, etc. The laboratory work carefully follows up this instruction, and consists in the testing of dynamos, motors, batteries, etc., and also gives the students practice in the actual construction of simple electrical apparatus. Frequent visits are made to electrical factories, plants, and stations.

The practical lectures of the second year are devoted to the management of dynamos, motors, engines, etc., electric lighting plants and stations, electric power, the construction and use of submarine, quadruplex and other telegraphs, the extraction, deposition and purification of metals by electricity and the theory of primary and secondary batteries. The mathematical course comprises the theory of varying currents and alternating current induction. The theory of the dynamo and motor covers the study of the alternating current dynamo and its characteristic, periodic currents, measurement of mutual and self induction, methods of measurement of alternating currents, transformers, etc. In the laboratory and workshop, practice is given in taking apart, putting together, and repairing of dynamos, motors, measuring instruments, and in the construction of electrical apparatus, such as winding armatures, etc.

Conferences are held one evening each week throughout the course to discuss current electrical literature.

The students have just finished the construction, for experimental purposes in the laboratory, of a battery of 1,280 cells which, when set up with Daniell elements, gives an E. M. F. of about 1,400 volts, and when set up as a storage battery an E. M. F. of about 2,800 volts. Some interesting results have been obtained from the experiments performed with this battery.

There has just been erected in the mechanical engineering department a hydraulic testing machine of 150,000 pounds capacity, and it is now to be used by the electrical engineering students for a series of tests, which, it is expected, may be of considerable theoretical and practical interest in electrical science.

SOCIETY AND CLUB NEWS.

NEW YORK ELECTRIC CLUB.

The election of officers at the Electric Club took place on April 17. The successful candidates were as follows: *President*—O. E. Madden; *Vice Presidents*—Grosvenor P. Lowrey, Erastus Wiman, A. H. Patterson, W. D. Sargent; *Secretary*—Charles W. Price; *Treasurer*—Willard L. Candee; *Board of Managers*—J. C. Chamberlain, H. L. Storke, John J. Carty, Cyrus O. Baker, Jr., J. H. Herrick, C. H. Barney, A. D. Stanley, H. C. Adams, George B. Coggeshall, Samuel Insull, John A. Seely, C. E. Stump, Henry A. Reed; *Committee on Membership*—Henry Hine, Lieut. F. W. Toppan, F. Z. Maguire, George T. Manson, and George Worthington.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the meeting of the Council of the Institute on April 15 the following gentlemen were elected to associate membership: G. W. Palmer, Jr., General Manager, McKeesport Light Co., McKeesport, Pa.; W. F. Bauer, Constructionist, The Electrical Accumulator Co., 62 Steuben street, Orange, N. J.; George B. Shaw, General Manager, National Electric Manufacturing Co., Eau Claire, Wis.; J. J. Carty, Electrician, Metropolitan Telephone and Telegraph Co., 18 Cortlandt street, New York; Arthur Churchill, Electrical Expert, Frazar & Co., Yokohama, Japan; Warren S. Belding, Electrician and Superintendent, The Belding Motor and Manufacturing Co., 6423 Stewart Boulevard, Chicago, Ill.; Herbert H. Eustis, President and Electrician, Eastern Electric Cable Co., 61 Hampshire street, Boston, Mass.; Marmaduke Burrell Holt, Student, Course of Electrical Engineering, Columbia College, New York; W. D. McQuesten, Electrical Engineer and Contractor, 15 Cortlandt street, New York.

THE LANGHANS INCANDESCENT LAMP.

The main characteristics of the Langhans incandescent lamp, recently brought out in England, are the low vacuum it requires and the employment of a metallic filament coated with silicium. As a vacuum corresponding to about one millimetre is all that is necessary, it can be produced by a mechanical vacuum pump specially constructed for the purpose by Mr. Langhans. The several processes employed in coating the filaments with silicium are said to be simple, inexpensive, and to permit of a high degree of accuracy in predetermining the voltage. The life of the Langhans filament at 2.75 watts per candle-power is said to be equal to that of the best carbon makes. Ordinary carbon filaments can be coated with silicium by the Langhans process, and it is claimed that they then require less current in order to give the same amount of light, and can be made to work satisfactorily in the same low vacuum as the Langhans filament proper.

WORDS OF GREETING.

THE ELECTRICAL ENGINEER, beginning with this month, becomes a weekly. This journal is one of the oldest of its class, and is undertaking the extra work involved in a weekly publication under exceptionally favorable conditions, through having now associated with their editorial staff Mr. T. Commerford Martin and Mr. Joseph Wetzler, long and widely known in electrical journalism.—*Architecture and Building.*

Our famous New York contemporary, the *Electrical World*, loses two men in Messrs. T. Commerford Martin and Joseph Wetzler, whose worth and ability cannot be excelled. Mr. Martin, from his long connection with the *World* in the capacity of associate and managing editor, has a personal historical knowledge of the development of electrical science possessed by few in this country. His efforts, which were so ably seconded by Mr. Wetzler, will now be turned to the advancement of THE ELECTRICAL ENGINEER, of the same city. Mr. Wetzler goes with him.—*Practical Mechanic.*

The publishers of THE ELECTRICAL ENGINEER announce that this publication will be issued weekly instead of monthly, beginning with the first week in April, and that it will give its attention distinctively to the great engineering problems and questions of electricity, proposing to "cover the whole domain of theoretical and applied electricity that its name implies." Numerous contributions from leading electricians and illustrations of the first order are promised. THE ELECTRICAL ENGINEER, which has already attained a high reputation in its specialty, is now conducted by Messrs. George M. Phelps, T. Commerford Martin and Joseph Wetzler.—*Railway Age.*

The growing importance of electrical interests is made manifest when a technical paper of the standard maintained by THE ELECTRICAL ENGINEER can be published weekly. It is a thoroughly scientific journal, not a mere repository of electrical items, and is of great value to students of electricity. Its editors are men of attainments, and its contributors are men whose names are inseparable from the development of electrical science.—*Boston Transcript.*

We are glad to find that this excellent paper is now to appear weekly instead of monthly as heretofore. Messrs. T. C. Martin and J. Wetzler, who have so ably edited another of our American contemporaries, will now conjointly conduct THE ELECTRICAL ENGINEER, and we wish them the best of success in their congenial occupation. Mr. Martin is, we believe, an Englishman, although personally not so well known in this country as his colleague Mr. Wetzler, who visited England so recently as the autumn of last year. Under their combined influence THE ELECTRICAL ENGINEER, as a weekly publication, should soon become the leading paper of the eastern part of the United States. —*London Electrical Review.*

A SUPPER SERVED BY ELECTRICITY.

A special dispatch from Baltimore, of April 11, says: "The Baltimore Bicycle Club gave an electrical dance and banquet tonight at the new club house. G. E. Painter, ex-member of the club, and an electrician, by an ingenious arrangement of wires produced some novel electrical effects. Two sets of musicians furnished the music. The dancing rooms were connected by folding doors. The musicians sat in the hall and the electric annunciators told them what dances to play, the leader of each set of dancers simply touching electric buttons in their respective rooms. In the supper room there was a track of small brass rails, on which was an electric car or basket about a foot long and thirty inches wide. This car conveyed the viands from the butler's apartment. The butler placed the courses in silver trays upon the car and sent them along the electric railway. The car stopped long enough in front of each plate for each guest to help himself. The car was also supplied with electric bells. The ballroom was beautifully illuminated by incandescent lights in the shape of tulips, lilies and other flowers. Under the tables were music boxes operated by electricity which played during the supper. Not a drop of coffee or a bit of ice cream was spilled by the electrical waiter."

LIGHTING THE U. S. CRUISER "NEWARK."

The Thomson-Houston company have obtained the contract for lighting the new cruiser "Newark." In connection with this the Armington & Sims Engine Co. have received an order for three double upright 7 x 5 engines. They are to be strictly of the marine type with many new improvements, giving the greatest amount of power for the least weight and area of floor surface. They will not be compound, as recent and exhaustive experiments by the French and English Navy Departments, it is said, condemn the small compound engines for ship lighting, and this contract has in a measure been awarded and based on their experience.

LITERATURE.

Fifth Annual Report of the Board of Gas and Electric Light Commissioners of the Commonwealth of Massachusetts. January, 1890. (Pub. Doc. No. 85.) Boston, 1890.

In 1885, the Legislature of Massachusetts established a Board of Gas Commissioners, for the purpose, mainly, as it appears, of regulating the relations between the gas companies and the public. The statute provided that every such company should make an annual return to this Board, showing its financial condition, and its current receipts and expenditures, and upon request should furnish any other information required by the board concerning its condition, management and operations. The board was further authorized to pass such orders, and take such action as it might deem necessary, in respect to regulating the quality or price of gas furnished by any company, upon the complaint made in writing, either of the authorities of any municipality or of not less than 20 consumers. By additional legislation in 1887, the jurisdiction of the Board was extended over all chartered electric light and power companies operating in the state, and it was provided that no such company should place its conductors in the streets of any municipality, except by consent of the local authorities given after a public hearing with due notice to all interested; and also that any party aggrieved by the decision of the municipal authorities might appeal to the Board whose decision should be final. In 1887, chartered gas companies were authorized to supply electric light within their territory, subject to the assent of the holders of two-thirds of the stock and to the approval of the Board; and under like restrictions were authorized to purchase the property and franchises of existing electric light and power companies within their territories.

The present report of the Commission is the third issued since its jurisdiction was extended over electric light companies; and brings the returns down to June 30, 1889. The Commissioners say that they have endeavored to keep in mind the welfare of the communities in which they have been called to act, and that they approve of the general policy of the Legislature in permitting but one company to do the lighting in the smaller cities and towns, mainly for the reason that the number of such companies which can conveniently do the business must necessarily be limited, owing to the nature of the work, and to the fact that much of it must be done in the public streets. In pursuance of this policy the Commissioners state that they have been compelled, in several instances, to deny to competitive companies the privilege of going into business, the only exceptions being when it was clearly shown that the new company could supply the community better and more cheaply than the existing ones. The number of chartered electric light and power companies in the state already considerably exceeds the number of chartered gas companies, the figures being as follows:—

Electric light and power companies	100
Gas companies	75

Of these gas companies, 26 are permitted to supply electricity.

The question of the comparative safety of water and coal gas is discussed *in extenso*. According to the best information obtainable, the number of deaths in the United States, from inhaling illuminating gas during the year 1889, is 107, of which at least 30 were suicides. It is worthy of note that 46 of these deaths occurred in hotels. The conclusion reached is that water-gas, either alone or mixed with coal-gas, is somewhat more dangerous than coal-gas alone, but the report suggests with much reason, that even if a thing in itself be dangerous, the very knowledge of this danger tends to prevent harm, by inducing a greater degree of care than would otherwise be exercised. A modification of the restrictions imposed by the present law upon the manufacture of water-gas is recommended.

The following figures which are compiled from the returns of several of the largest companies, throw some light on the much mooted question of the actual cost, per cubic foot, of coal-gas in the holders:—

Gas coal	42 to 43 cents	
Oil	3 to 7 cents	
Residuals (deducted)	13 to 23 cents	
Net cost of materials		20 to 30 cents.
Labor		14 to 20 "
Repairs		5 to 8 "
Total		39 to 58 "

The aggregate receipts for gas sold by meter, notwithstanding a general reduction in average price, show a gain in 1889, of $127,000, while receipts from street lights fall off about $44,000, or 11 per cent. This indicates that the electric light, while affecting the gas companies' street lighting, has not as yet reduced their receipts from sales by meter.

A large amount of statistical matter is given in detail in tabular form, the usefulness of which might have been materially enhanced by a more extended and intelligent summarization of the results. Separate statements showing the financial condition of each gas and electric light company are given in an appendix, and in the case of the gas companies the yearly statement of profit and loss, which for some reason not explained, is omitted in the case of the electric light companies, both individually and in the aggregate. Although no figures are given which directly show the cost of electric light operations, it might be possible to arrive at them indirectly with some accuracy, if it were worth while to do so. The aggregate assets and liabilities of the gas companies, and the results of the year's operations are summarized in the following table, which we have compiled from the figures given in the report:—

GENERAL BALANCE SHEET.

Total assets of all the companies		$20,930,666 07
Capital stock	$12,705,000 00	
Bonded debt	346,100 00	
Other indebtedness	5,324,442 64	
Total liabilities		18,375,542 64
Reserve funds and surplus		$2,555,123 43

PROFIT AND LOSS ACCOUNT FOR 1889.

For gas sold by meter	$4,027,049 67	
For gas supplied public lamps	352,934 84	
For sales of by-products, etc	489,357 60	
Total gas receipts year ended June, 30, 1889.		$4,869,342 11
Total expenditures of all kinds,		3,314,337 98
Leaving a net profit on gas business.		$ 1,555,001 13
To which add receipts from electric lighting.		54,318 62
And from other sources		80,621 83
Total receipts from all sources		$ 1,689,944 58
From which were paid dividends aggregating		1,086,884 12
Leaving surplus to be carried forward of		$608,560 46

The assets and liabilities of the electric companies, as given, show an aggregate capital of $4,837,085, and a total bonded and floating debt of $1,643,936. An examination of the returns in detail, shows that a large number of the electric companies have been started with a wholly insufficient capital, and in not a few instances it may be feared that, their borrowing capacity having been exhausted, they are confronted with a large business which they have neither the plant nor the capital to handle properly. The gas companies have apparently been, as a rule, much more conservative in this respect. We have made up the following summaries from the figures given which will be found of interest:—

Dynamos,

Aggregate number of dynamos	368
Aggregate rated horse power of dynamos	29,818

Dynamo Capacity.

2,000 c. p. lamps (arc)	7,103
1,200 c. p. lamps "	4,301
1,500 c. p. lamps "	165
800 c. p. lamps "	140
16 c. p. lamps (incandescent)	80,955
20 c. p. lamps "	8.400

Arc Lamps.

Number of single arc lamps	5,463
" " double " "	3,375
Total	8,838
Commercial arc lamps	3,916
Public arc lamps	4,922

Meters.

On arc circuits	111
" incandescent circuits	379
" power circuits	48
Total	538

Incandescent Lamps.

Commercial incandescent lamps. (Of which 2,438 are on arc circuits.)	72,419
Aggregate horse power of electric motors (stationary)	1,442

Arc Carbons Used During the Year.

Plain	986,473
Coppered	2,976,666
Total	3,963,139

From the above figures it appears that nearly the full rated capacity of the incandescent dynamos is employed.

If we assume that the actual number of lamp hours is 12 per cent. of the maximum, which is probably not far from the truth, the light given by 72,419 incandescent lamps in one year is equivalent, in round numbers, to about 381,000,000 feet of gas.

Nearly all the incandescent lamps in the state, except those of the Edison companies, at Boston, Brockton, Fall River, Lawrence and New Bedford, are run on a "contract" and not on a "meter" basis. Sixteen candle incandescents are ordinarily charged at 1¼ cents per hour by meter, and $10 to $12 per annum on contract. For arc lights the price is variable, all-night lamps, seven nights per week, being charged from 40 to 65 cents per night, 50 cents being perhaps the most usual figure; or by the year at $180. For shorter hours a proportionate sum is charged.

The figures in this report are quite sufficient to show that in the contest between the gas and electric lighting industries, the latter are not by any means going to have a "walk-over," although the field open to them is much better in some towns than in others, as will appear for example by comparing the returns in Worcester and Lowell, two cities of approximately the same population. In the former the sales for the year amounted in round numbers to 105,000,000 feet, and in the latter to 200,000,000 feet, the average price in Worcester being $1.50, and in Lowell, $1.10 per thousand. If space permitted we might point out a number of other matters which are equally well worthy of consideration.

OBITUARY.

Johann Georg Halske.

We regret to record the death of Johann Georg Halske, the co-founder and, for many years, partner of the well-known firm of Siemens & Halske. He was born at Hamburg on July 30, 1814, and went to Berlin, where he set up an engineer's shop in 1844. Soon after, he made the acquaintance of Werner Siemens, who, in Halske's workshop, assisted by Halske's mechanical skill, was able to work out his first inventions in telegraphy, so as to bring them before the public. In 1847 the two men entered into partnership, and laid the foundation for the electrical industries which at the present day give employment to thousands of workmen, both at Berlin and Charlottenburg, and at several branch establishments. Halske left the firm in 1867, and since then has been an active member of the municipality of Berlin.

LEGAL NOTES.

EDISON ELECTRIC ILLUMINATING CO., OF PATERSON, N. J., vs. J. STRIEF.

The Edison Electric Illuminating Co., of Paterson, N. J., lately brought suit in the District Court against Jacob Strief, alleging that seven Edison lamps had been installed on defendant's premises, in consequence of an agreement by the consumer to pay for the service as per "meter bill." The first bill rendered for a month's use amounted to $34.40, and payment of same was refused. In court defendant maintained that he had never "given an order for the installation of the lights, and that as he did not use them all, he did not see why he should be asked to pay for the installation of the lights and for more current than he used." The Court, however, found that even though there was no contract, still his usage of the lights made him responsible for the installation of them, and of course he must pay for the amount of current used as indicated by the meter of the company. This showed the amount claimed ($34.40) to be correct, and judgment was accordingly given for the plaintiffs.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 15, 1890.

Alarms and Signals:—*Signal-Box*, M. Martin, 425,576. *Electric Call*, J. B. Currier, 425,594. *Electric Call*, D. H. Rice, 425,630.

Conductors, Insulators and Conduits:—*Insulator*, W. P. Kookogey, 425,513. *Insulating Compound*, A. A. Knudson, 425,615. *Wire Conduit*, A. J. Smith, 425,918. *Electric Conductor*, E. Tortora, 425,917. *Electric Conductor*, P. Seubel, 425,961.

Distribution:—*Distribution of Electric Currents*, E. Thomson, 425,470.

Dynamos and Motors:—*Brush-Holder for Dynamo Electric Machines*, F. A. La Roche, 425,435. *Commutator for Dynamo Electric Machines*, T. A. Edison, 425,763. *Method of Operating Synchronous Alternating Current Motors*, C. Zipernowsky, 425,923.

Galvanic Batteries:—L. M. J. C. C. Renard, 425,959.

Lamps and Appurtenances:—*Cut-Out*, C. Batchelor, 425,726. *Incandescent Lamp Socket*, J. J. Bradley, 425,741. *Incandescent Lamp*, T. A. Edison, 425,761. *Cut-Out for Incandescent Electric Lamps*, T. A. Edison, 425,762.

Measurement:—*Electric Meter*, V. Popp, 425,579. *Measurement of Electricity in Distribution Systems*, T. A. Edison, 425,760.

Miscellaneous:—*Electric Snap-Switch*, C. J. Hamilton, 425,507. *Thermo-Electric Battery*, J. Edelkamp, 425,568. *Cloth-Cutting Machine*, M. Hofheimer, 425,572. *Electric Temperature Controller*, E. H. Parker, 425,625. *Electric Door-Opener*, W. L. Godfrey, 425,777. *Phonograph Recorder*, J. H. White, 425,840. *Electric Switch*, E. P. Warner, 425,963.

Railways and Appliances:—*Car Telegraph*, W. F. Stevens, 425,466. *Contact Device for Electric Railways*, F. O. Blackwell, 425,488. *Electric Railway Contact*, F. O. Blackwell, 425,489. *Method of Transferring Batteries*, W. B. Cleveland, 425,493. *Electric Car Motor*, E. Peckham, 425,627. *Guard for Electric Railway Trolleys*, E. Thomson, 425,640. *Safety Attachment for Electric Railway Trolleys*. F. C. Wheeler. 425,720. *Electric Heating Apparatus for Electric Railway Systems*, M. W. Dewey, 425,757. *Electric Railway*, T. A. Evans, 425,767. *Electric Railway Car*, M. W. Dewey, 425,866. *Electrically Propelled Car*, R. M. Hunter, 425,883. *Electric Railway*, R. V. R. Sill, 425,911 and 425,912. *Electric Railway*, W. H. Knight, 425,950. *Electric Railway System*, D. G. Weems, 425,964. *Electric Railway*, D. G. Weems, 425,965 and 425,966.

Secondary Batteries:—*Secondary Battery*, J. F. McLaughlin, 425,818. *Secondary Battery Electrode*, J. F. McLaughlin, 425,819. *Secondary Battery*, G. Philippart, 425,902 and 425,957.

Telegraphs: *Balanced Pen for Autographic Telegraphs*, H. Etheridge, 425,413. *Telegraph Transmitter*, F. W. Jones, 425,511. *Receiving Apparatus for Cable Telegraphy*, P. B. Delany, 425,597.

Telephones and Appliances:—*Telephone Bell and Connection*, D. H. Rice, 425,631. *Electric Circuit for Telephone Purposes*, A. W. Berne, 425,853. *Multiple Telephony*, J. J. Carty, 425,862. *Telephone System*, J. J. Carty, 425,868.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

A LARGE NUMBER OF NEW STREET RAILWAY CONTRACTS.

We understand that the Sprague Electric Railway and Motor Co. have closed a large number of contracts for the electrical equipment of street railways during the last month. These contracts came from all over the country, a large number of them being noticeably from street railway companies which already have a number of cars in operation upon the Sprague system.

No argument as to the popularity of electric railways could be made more convincing than this fact, which is so common, of additional equipments ordered by street railway companies where the system has been tried. When a company continues to order additional equipment there is only one conclusion to be drawn, *i.e.*, that the system is a success.

The most recent contracts in regard to the Sprague company are as follows:—

Augusta Street Railway, Augusta, Ga., 16 car equipments: Paducah Street Railway, Paducah, Ky., 9 car equipments; Fort Worth & Arlington Heights Railway, Fort Worth, Tex., 3 car equipments; Troy (N. Y.) & Lansingburgh Railway, Troy, N. Y., 12 car equipments; Metropolitan Railway, Portland, Oregon, car equipments; Passenger & Belt Railway, Lexington, Ky., 4 car equipments; Atlantic City (N. J.) Electric Railway 1 car equipment; Detroit (Mich.), Rouge River Dearborn Railway, 4 car equipments; Union Street Railway, St. Joseph, Mo., 6 car equipments; Sioux City, Ia., Street Railway, 5 car equipments; Dallas (Tex.) Rapid Transit Railway, 1 car equipment.

DAY'S "KERITE."

Mrs. Sarah A. Day, the administratrix of the estate of A. G. Day, deceased, has now issued an announcement of the fact that the large business known under the name of Day's "Kerite" will be carried on as before, and that Mr. George B. Prescott, Jr. has been appointed general agent, assuming charge at once, at 16 Dey street, this city. Mr. Prescott also issues a circular, in which he advises his personal, professional and business friends of the new departure, and hopes "that the users of 'Kerite' will continue to approve its qualities as they have so generally done in the past, and that all others who desire a trustworthy and durable insulation, that has been successfully employed for aerial, subterranean and submarine purposes for upwards of 25 years, will test its merits."

THE SHAVER MOLECULAR TELEPHONE.

There can be no mistake as to Mr. H. H. Warner's intention to push the Shaver "Molecular" telephone, which has recently been illustrated and described in these pages. Following his well-known and successful methods of attracting and holding public attention, he has issued no fewer than *ten* million circulars on the subject, thus reaching, it may be said, every adult in the United States. We believe that no invention ever before was the subject of such publicity, or at one time was brought so prominently and persistently to the notice of possible patrons. Mr. Warner sees that 300,000 people appreciate their telephones highly, and he proposes to be a benefactor by supplying the wants in this respect of at least 3,000,000 more. With regard to the efficiency of the Molecular apparatus, the Shaver Corporation publish in this issue in our advertising pages a fac-simile of the Government specification—which we have seen—in which their telephone is named and called for as the standard. It is a striking piece of testimony to its value.

W. R. OSTRANDER & CO.

Owing to the great increase in their business, W. R. Ostrander & Co. are compelled to remove their offices from Ann street, and on May 1 they will locate at 195-197 Fulton street, three doors west of Church street, where they will carry in stock a full line of speaking tubes, whistles, electric, mechanical and pneumatic bells, annunciators and general bell-hangers' supplies. Not long since the factory facilities were greatly increased by Mr. Peck, so that the concern is now in good shape to fill the largest orders.

PAGE BELTING.

The Page Belting Co., of Concord, N. H., manufacturers of leather belting in all the staple grades, also manufacturers of the following specialties: the "Acme Link," the "Eureka" dynamo belt, also lacing, both tanned and raw hide, report a very large increase in business in March over the corresponding month of last year. They have recently completed additions to their works, which are now fully occupied in turning out such quantities of goods as their increased facilities allow. They report a very large increase of business in their "Acme" link belt in particular,—a belt specially adapted to fast-running machines like dynamos. Their trade in the Northwest is largely extended by means of the recent opening of their store in Chicago—165 Lake street—under the management of F. F. Wormer. Among the large shipments of belting made during the past month, are, one to Portland, Ore., and another to San Francisco, Cal.

"MAGNOLIA" ANTI-FRICTION METAL.

The Magnolia Anti-Friction Metal Co., 74 Cortlandt street, New York city, have issued photographs of some journal bearings tested recently, showing the superiority of the Magnolia metal. These tests were made by Dr. H. G. Torrey, a member of the American Society of Mechanical Engineers, and the well-known assayer to the United States Mint of this city. Mr. Corliss, builder of the famous Corliss engine, in his work on friction, gives 2,000 feet as the limit of velocity of rubbing surface per minute in machinery; and, as shown on the photograph, this limit was attained in the test of Magnolia metal and under the enormous pressure of 1,425 pounds to the square inch. These two limits have rarely, if ever, been attained before in practical mechanics.

THE RIVER AND RAIL ELECTRIC COMPANY.

It is stated that this company will probably purchase the factory of the Taylor Hardware Company at New Britain, Conn., and establish a large manufacturing plant there. The company's New York offices are at 45 Broadway. Mr. G. L. Wright is the manager.

THE BALL ELECTRIC LIGHT CO.

The above company will remove their offices on May 1 from 18 Cortlandt street to 404 West 27th street, this city. They report a steady business and a good outlook.

THE NEW WESTINGHOUSE LIGHTNING ARRESTER.

The new Westinghouse lightning arrester which we illustrated in a recent issue is attracting considerable attention among electricians. Besides its simplicity of construction and certainty of operation it possesses the additional advantage that its construction embodies no coils of wire or magnets whatever, thus offering no impedance to the passage of the lightning charge, due to the high self-induction which takes place when electro magnets are in circuit. Our attention has been called to the fact that the new arrester is the joint invention of Messrs. Paul Winsor and Alexander Wurts of the Westinghouse Company.

SCHIEREN "ELECTRIC" LEATHER BELTS.

Chas. A. Schieren & Co. have just received an order from the Citizens' Electric Illuminating Co. of Brooklyn, N. Y., for $98\frac{3}{12}$ feet of 42″ three-ply "Electric" leather belting. They previously sold this company:

106 feet, 42″ Double Elctric Belting,
98 " 42″ " " "
115 " 36″ " " "
115 " 36″ " " "
89 " 36″ " " "
89 " 36″ " " "
115 " 36″ " " "

for "main drive" and all the necessary dynamo belts in addition to this. They have also furnished the Municipal Electric Lighting Co. of Brooklyn with:

$109\frac{7}{12}$ feet, 48″ Double Electric Belting,
113 " 48″ " " "
$93\frac{3}{12}$ " 20″ " " "

for main driving belts, and about 325 of 8″ double electric belting to run their dynamos.

OKONITE.

That Okonite insulated wire will stand a large amount of rough treatment without impairing its utility has been a point always claimed by the manufacturers. Corroborative testimony in a matter of this kind is always acceptable, and those who may have had any doubts regarding the durability and thorough insulation of wire covered with this famous insulating material when used under adverse circumstances, should read carefully Foree Bain's acknowledgement of its good qualities, printed in our pages this issue.

THE CONTINENTAL TELEPHONE CO.

The above company organized in 1879 to exploit the "Bell" telephone, "Blake" transmitter, and kindred telephonic devices in South America, Central America and West Indies, have just voted a final dividend of $10 per share to their stockholders, to be paid on the 26th inst. to those who own, present and surrender their certificates. The Tropical American Telephone Co., L'td., is the successor of this company in the territory above named.

NEW ENGLAND TRADE NOTES.

Pettingell, Andrews & Co. have now got thoroughly settled down in their enlarged quarters, and have now the largest floor space of any electric supply house in the country. All the goods are exhibited on one floor, and with the two new young partners, Messrs. D. A. Andrews, Jr., and C. W. Price, to attend to customers, it makes a most convenient and pleasant store to do business in. Besides their large stock of cut-outs, switches, fuse boxes, etc., Messrs. Pettingell, Andrews & Co. are now making a specialty of carrying a large stock of wires, and have Okonite, P. & B., American Weatherproof and Underwriters, constantly on hand.

Mr. L. H. Rogers, who has made himself most favorably known throughout New England as agent for the Brush Electric Co., has just been appointed agent also for the Short Electric Railway Co., of Cleveland, O. Mr. Rogers reports that the new type of motor has been adopted by Tom and A. L. Johnson, the electric railway magnates of Cleveland, and that the Short company has recently closed the largest contract for an electric railway ever given out, namely, the contract for an electric railway at Rochester, N. Y., which includes 55 miles of track, 200 motor cars, and a complete generating apparatus of from twelve to fifteen hundred horse power. Mr. Rogers intends in the near future to make an onslaught on the railway business of New England.

The Simplex Electrical Co. have got out a new price list and catalogue of their various wires, which is considerably above the ordinary average. In it are contained many valuable tables and formulæ, and a complete treatise on the calculation of wires for safe carrying capacity. The book is valuable to every practical wireman and electrical engineer, and should be procured at once.

The Electric Safety Co. has opened an office at 146 Franklin street, Boston, with Mr. J. H. Coombs as manager, and Mr. D. J. Cartright as electrician, for the purpose of selling apparatus for the protection of electric circuits and instruments, from heavy currents and lightning. They will push especially the Cartright protector, which was warmly endorsed recently by the Boston Fire Underwriters' Union, as being a perfect protector for all kinds of electric circuits.

The New England Safety Co. has opened an office at 146 Franklin street, with Mr. E. E. Zimmerman as manager, for the sale of the well-known Crandall protector. At the recent tests made by the Boston Fire Underwriters' Union this instrument received very warm commendation, and it is already extensively used by the Chesapeake and Potomac Telephone Co., some 8,000 of the instruments being in use by this company. It has also very recently received the warm endorsement of the Department of Public Safety (Bureau of Electricity) in Pittsburgh.

The Boston Electric Club held its monthly dinner at the Quincy House, on Monday evening the 14th inst. at which there were about 60 members present, President Cram being in the chair. Mr. Joseph Wetzler, editor of The Electrical Engineer read an interesting paper (reported elsewhere) on "Electric Railway Evolution," and illustrated the lecture by numerous stereopticon views. Afterwards Mr. Monks, general manager of the West End Street Railway Co. and Mr. George W. Mansfield of the Thomson-Houston Electric Co., made interesting remarks relating to the subject, and a vast amount of useful information was derived.

By the courtesy of Mr. C. F. Hutchinson, general superintendent of the New England Printing Telegraph Co., and Mr. R. D. Wilson, the writer had the pleasure of sending an immediate message this week to one of the representatives of The Electrical Engineer, in New York, which required an immediate answer. From his experience he can cheerfully commend the working of the Essick printing telegraph as to accuracy and speed in every detail, and predicts a large and profitable field for it in the immediate future.

The Westinghouse Electric Street Railway Co. is the latest development in electric street railway work. This organization is now in the field ready for business, and already has some large contracts in hand. Messrs. H. McL. Harding, J. L. Barclay and C. C. Warren, gentlemen well and widely known in electrical circles, are connected with the company and will handle the selling department. With such well-tried talent, business will undoubtedly pour in.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

Geo. M. Phelps, President. F. R. Colvin, Treas. and Business Manager.

Edited by
T. Commerford Martin and Joseph Wetzler.

New England Editor and Manager, A. C. Shaw, Room 70—620 Atlantic Avenue. Boston, Mass.
Western Manager, W. F. Collins, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada.	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April 9, 1888.*]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* The Electrical Engineer. *Communications for the attention of the editors should be addressed,* Editor of The Electrical Engineer, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

Vol. IX. NEW YORK, APRIL 30, 1890. No. 104

Nothing is so good as an experiment which, while it sets an error right, gives as a reward for our humility in being reproved, an absolute advancement in knowledge.—Faraday,

LOSS BY HYSTERESIS.

THE communication by Professor Elihu Thomson in our columns this week in reply to thatof Mr. Nikola Teslaon the loss due to hysteresis in transformers is well worthy of careful study, as it embodies an expression of opinion on a subject which is of foremost interest at the present time. Leaving out of consideration the purely controversial part of Professor Thomson's letter, it will be found to give his views on the probable origin of the heat generated by a change in magnetism, independent of the Foucault currents generated thereby. Professor Thomson uses a beautiful analogy to explain the difference in the heat generated by the current in various conducting bodies and that generated in distorting them mechanically; the heat in both cases depending upon whether the ether strain can be transmitted from molecule to molecule without much disturbance of their positions, or without causing a swinging-out of position back and forth. The subject is one that offers wide scope for speculation, and we shall probably find many theories advanced before the light of actual facts is thrown on the true explanation of the phenomena of hysteresis.

PRICES FOR CITY LIGHTS.

It is difficult to believe that the city authorities can be serious in their suggestion that unless the electric light companies reduce their bids, a return may be made to gas for the streets. One of the grounds of complaint is that the companies have entered into a combination to prevent competition. Another is that the prices average 15 per cent. higher than last year. An obvious reply in the first instance is that while there is no combination, there may well be an agreement not to do business at a loss. The prices are generally in the neighborhood of from 39 to 42 cents, and everybody knows that those rates are fair and reasonable, especially in view of the enhanced cost still attending operation in the subway districts.

What may be at the bottom of all this attack we do not pretend to know, but we do not hesitate to characterize it as a disgrace and a shame.

ELECTRIC TRACTION AND THE STORAGE BATTERY.

One of the most important events in electrical matters to-day is the formation of the United Electric Traction Co., with a capital stock of not less than $7,000,000. This company is a consolidation of the Daft and Julien companies, each of which is well known in its respective field of work and has done much to bring electric traction up to the position that it now occupies so commandingly in the industrial and financial world.

Momentous results are, in our opinion, to be expected from this massing of forces, and not the least of these will be a sudden and lasting activity in storage battery traction. The rapid increase in electric railway work in this country during the past two years has been almost wholly due to the use of methods involving the direct supply of current to the cars. In fact, the proportion of roads operating by any other system than that of the trolley and overhead wire is quite insignificant. Various reasons account for the lack of storage battery roads, and one of the gravest has been the uncertainty and weary delay always attendant upon patent litigation. The faith of those who believe in the future of storage traction and who have chafed at the slowness of its general adoption, is however, likely to receive an early encouragement in the new state of affairs. The Julien Company carries with it, we believe, its option on the Brush patent so recently adjudicated upon, and the Daft Company is able to supply everything needed for the equipment of a road. The Daft Company has also, of course, its familiar systems for direct operation.

It seems not at all impossible that this consolidation may lead to other notable changes, but be that as it may, it is important enough in itself to deserve more than passing comment. There are a great many places where the introduction of electric traction without storage batteries is attended with difficulties practically insuperable, and it is sincerely to be hoped that the way may now be made clear for an extension of work in New York; so that the whole city may enjoy the luxurious travel that has been the privilege for a while of the people along the line or in the vicinity of Fourth avenue. The time is ripe for electric traction in New York.

SECTION 4,887.

It has been rumored in Washington that the House Committee on Patents is likely to recommend the unconditional repeal of the last clause of Sec. 4,887, of the Revised Statutes, which makes the term of a domestic patent depend upon that of the prior foreign patent having the shortest term. The removal of the vexatious limitation, with its attendant uncertainties touching the validity of many patents, is much to be desired, not less in the interest of the public than in that of inventors and of the owners of property in patents. But it would, we think, be a grave mistake not to except from the provisions of the repeal patents which may hereafter be issued on applications which shall have been pending at the time of passage of the act. It is well known that applications are in existence covering important inventions which have been in the Patent Office for many years. The corresponding foreign patents have expired, and the inventions have gone into extensive public use on the faith of the provisions of the existing law. If the repeal be made unconditional, the owners of these pending cases may be able to put several important industries under a seventeen years' tribute, which would be, to say the least, most unfortunate. It is to be hoped that this consideration will be strongly urged upon the attention of Congress, when the matter comes up for action.

The Late Charles W. Jenks.

THERE will be found in our pages this week an obituary sketch of the late Charles W. Jenks, who was distinctively a pioneer in more than one department of electrical application, and who at the time of his death was busily engaged introducing the electric motor for mining purposes. Mr. Jenks was typically American in his readiness and versatility, his resilience under the pressure of adverse circumstances, his buoyancy of hope and courage, and, above all, in his generous spontaneity of sympathy and active goodwill. We held it an honor to enjoy his friendship and esteem, and are glad to add a modest tribute to his memory.

Comfort In Hotels.

A LEGAL decision in Tennessee holds that a guest cannot be charged for a fire in his room, the hotel having tacitly agreed to make him comfortable when it opened its doors for business. The incident is not without suggestion. It stands to reason that the hotel giving its guests the greatest number of comforts and conveniences will draw the largest custom. On this principle the hotel with electric lights, electric annunciators, bells, etc., will be more attractive than another without them. We believe, for example, that any hotel in our cities, during the summer time, putting in electric motor fan outfits and advertising "bedrooms cooled all night by electric fans" will through that very innovation secure an enormous share of patronage. Have our motor friends tried to work up such a business?

Exhibitions as Educators.

IT will be remembered by those of our readers who had anything to do with the Electrical Exhibition at Philadelphia in 1884, that the Franklin Institute, through Mr. G. M. Eldridge, secured the attendance of a large number of school children, the official record showing the formal visits of no fewer than 97 schools, 740 teachers and 16,657 students. Great good was done by this use of the Exhibition in an educational way, and we venture to suggest to the management of the Women's Exchange Electrical Exhibition in this city that they could develop the idea now to their own advantage and to the decided benefit of the school children of New York. A better "object lesson" for young inquiring minds could not be found than the telephonic, phonographic, lighting and power exhibits and experiments at the Lenox, illustrating the various arts as they exist most perfectly at the present time.

The Foe of Thief, Moth and Worm.

REFERENCE was made in our columns recently to an invention that proposes to destroy insects by luring them against a charged cage within which is an intense electric lamp, the shock from the bars killing them. The *Manufacturers' Record* quotes our article in full, and in its editorial comment makes the interesting statement that at Durham, N. C., since the city has had electric illumination, the ravages of the tobacco worm have been greatly reduced. It suggests that a powerful electric light in the centre of one of the sea islands growing the famous long staple cotton might save all the plantations surrounding it from the destruction so frequently wrought by the cotton army worm. The idea is ingenious, and it seems to us that such lights would also be very useful during the ingathering of the crop.

Honoring with Official Abuse.

FOR some reason best known to himself, Mayor Grant takes special pleasure in girding at Dr. Wheeler, the efficient and zealous electrical expert of the Subway Board, whenever a chance can be secured. Last week he seized an opportunity to scold, and made the most of it, some of the papers following his lead. Possibly the feeling is of a personal nature, but that is hardly likely, since Dr. Wheeler is not a politician with a pet Christian name, and, on the other hand, it is well known that the Mayor's educational qualifications are not such as to bring him in competition with Dr. Wheeler on professional grounds. It is a great pity and evil that engineers and other trained men in the city's service should be exposed to this sort of thing in the discharge of their duty. We advise Dr. Wheeler, however, to maintain his equanimity and to leave the Mayor to Time and the Investigating Committees.

Hopkinson on Magnetism.

IN this issue we bring to a close Dr. Hopkinson's admirable résumé of the present state of our knowledge regarding magnetism. The phenomena of recalescence and the peculiar behavior of the alloys of nickel, manganese, cobalt and iron have recently opened up a new field for investigation, and this paper of his will assist towards arriving at a more comprehensive theory of magnetism than has yet been advanced.

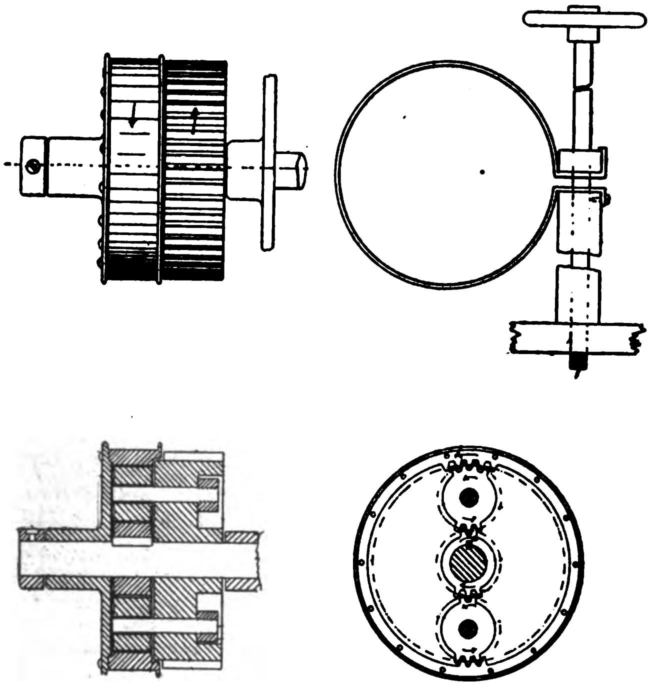
Growth of Light and Power Interests.

THE annual report of the Thomson-Houston Electric Company, given in our columns to-day, shows that the company had at the beginning of the year a clientage of 587 local companies using its arc and incandescent systems. The list we give of electric railway companies operating under the Sprague system shows a total of no fewer than 1,228 motor cars. A comparative statement from Pittsburgh shows that if the business of the year is maintained at the present rate, the sales of the Westinghouse company will aggregate $7,500,000 as compared with $4,500,000 in 1889. And yet these are but a few of the figures that could be cited to prove the enormous development of electrical industries at the present time.

HENRY'S ELECTRIC CAR GEAR.

In a recent issue we had occasion to point out the fact that the frequent starting and stopping of the motors on electric cars was a source of considerable loss as well as a strain on the motor. We illustrated at that time a device of Mr. J. C. Henry to avoid these objections, but are enabled this week to describe the apparatus actually employed by him in his roads at Kansas City and San Diego, several years ago.

The motor gearing, or rather the connection between the motor and the car axle is shown in the accompanying engravings, Figs. 1, 2, 3 and 4. It consists of a pinion keyed to the motor shaft, is surrounded by an internal gear loosely mounted on the same shaft, and intermediate pinions engaging with both of them. The intermediate pinions are loosely mounted on pins which in turn drive an external gear, engaging with one on the car axle



Figs. 1, 2, 3 and 4.—Henry's Electric Car Gear.

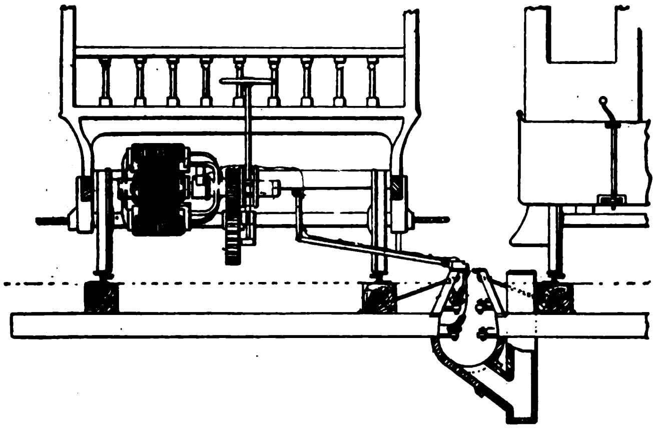


Fig. 5.—Henry's Electric Railway Conduit.

The armature runs constantly, and when the car is standing the armature and internal gear are revolving freely. As the internal gear is retarded by the clutch, the car moves, gradually increasing its speed until the maximum is reached. In this case the internal gear is held stationary. In order to stop the car the clutch is released; this disconnects the armature and, at the same time, the continued movement applies the car brakes. In practice, wooden shoes are used on the clutch and they are kept lubricated. By allowing the clutch to slip, a strong yielding leverage can be had to start heavy loads or climb heavy grades, as demonstrated during four years' use of this device by Mr. Henry.

The main object of the arrangement, as remarked above, is to prevent abnormal currents in the motor and to avoid breaking the circuit. By the employment of an internal gear, strength and compactness are obtained and it permits the speed-reducing parts to work in an oil bath perfectly free from dust. The advantages of this are apparent.

It will be noticed that the movement is a differential one. With pinions of the same diameter, the intermediate gears make a single planetary turn to four complete turns of the central gear.

The engravings, Figs. 5 and 6, show a sectional view of the construction of the Henry conduit, the main electrical features of which are the location of the separate conductors, the return conductors being placed below. It may thus be covered with water without detriment to the operation of the road. The conductors are supported from oil cup insulators, and the traveling contacts are springs which grasp and cling to the conductors. It will also be noticed that but a single conduit and slot are employed for a double-track road.

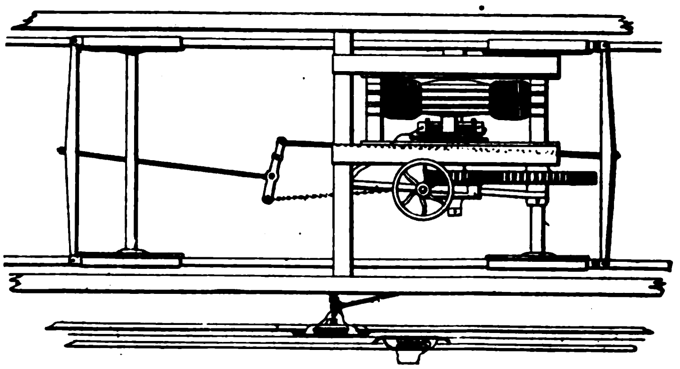


Fig. 6.—Henry's Electric Railway Conduit.

EPSTEIN'S SECONDARY BATTERY PLATES.

There are still a number of inventors at work on the storage battery who are devoting their attention to the perfection of a plate not provided with the active material mechanically applied, but in which it is formed upon the plate by chemical and electrical means. Among those who have in the past followed this method is Herr Ludwig Epstein, of Berlin, Germany, who has recently brought out a process of plate formation for both positives and negatives, which embodies several novel features, and the object of which is to obtain a quick formation without loss in capacity or durability of the plate.

This object is obtained by dividing the process of manufacturing the electrodes into two separate parts, the first part being limited to the making of so-called "raw" electrodes, which latter are then transformed into positive electrodes with the assistance of the electric current in an electrolyte containing either diluted sulphuric acid or a suitable compound of sulphuric acid, while the negative electrodes are formed by a reduction of the positive electrodes. In order to obtain the so-called "raw" electrodes that furnish the raw material for the final electrodes, bodies consisting of lead of any shape whatever and suitable for use as electrodes are put into water rendered acidulated by the addition of a small quantity (about one per cent.) of nitric acid, and then this water is heated up to the boiling-point. The lead bodies immersed in water of this kind are kept from coming in contact with each other by being suspended in such a manner that the fluid has access to them all around. The water is always kept up to the boiling-point, and the boiling is continued till the metallic "glance" that the lead bodies originally had has disappeared and the lead has assumed a dull gray appearance. The lead bodies thus treated are then taken out of the boiling water and dried in the air.

By this action there is produced on the lead bodies a grayish yellow deposit of lead compounds which is fine grained in structure and has the appearance of mildew.

This deposit adheres very firmly and is insoluble in the electrolyte used for the subsequent treatment in dilute sulphuric acid. In addition it has a great capacity for taking up the gases engendered in the formation process, so that the latter may proceed quickly, without the necessity of reversing the current. It is these "raw" plates as they are called from which the positives as well as the negatives are formed.

In order to form positive electrodes, a number of raw electrodes forming a group are put into the electrolyte, lead plates being inserted between them; or they are put in together with positive electrodes that have to be transformed into negative electrodes. The raw electrodes that have to be formed into positive electrodes are then connected with the positive pole of the primary current and the intervening plates with the negative pole of the primary current, by which means the formation of the electrodes by the effect of the electrolyte commences as soon as the current is turned on. In this process of forming positive electrodes the former grayish-yellow color of the raw electrodes changes into a deep dark-brown, almost bluish-black hue, and the process is completed as soon as the electrodes have assumed that color, and an abundant development of gas (oxygen in this case) takes place on the positive electrodes thus formed.

For the purpose of forming negative electrodes part of the lead bodies converted into positive electrodes by the process just described are used in the place of the lead plates inserted between the electrodes formed into groups, as above mentioned, in the formation of positive electrodes.

The oxygen of the peroxide of lead produced on the positive electrodes which are to be reduced is absorbed by the effect of the electric current and the bodies are reduced on their surface to porous metallic lead. The process of forming negative electrodes is finished when the deep dark-brown or bluish-black color of the positive electrodes used for the purpose has changed into a bluish-gray hue and an abundant development of gas (in this case hydrogen gas) takes place on the negative electrodes thus formed.

The advantage in favor of the method just described is in particular that for forming electrodes of one sort from the raw electrodes prepared in the way described, a few hours only are necessary, and the reversing of the electric current used in other processes for this operation is unnecessary, so that in a very short space of time a great number of positive as well as of negative electrodes can be produced. Further advantages are also claimed in that these electrodes last extremely well, and that even in case of frequent heavy charging and discharging there is no scaling. They are claimed also to afford a far greater storage capacity, weight for weight, than the types of plate in general use.

THE EDELKAMP THERMO-ELECTRIC BATTERY.

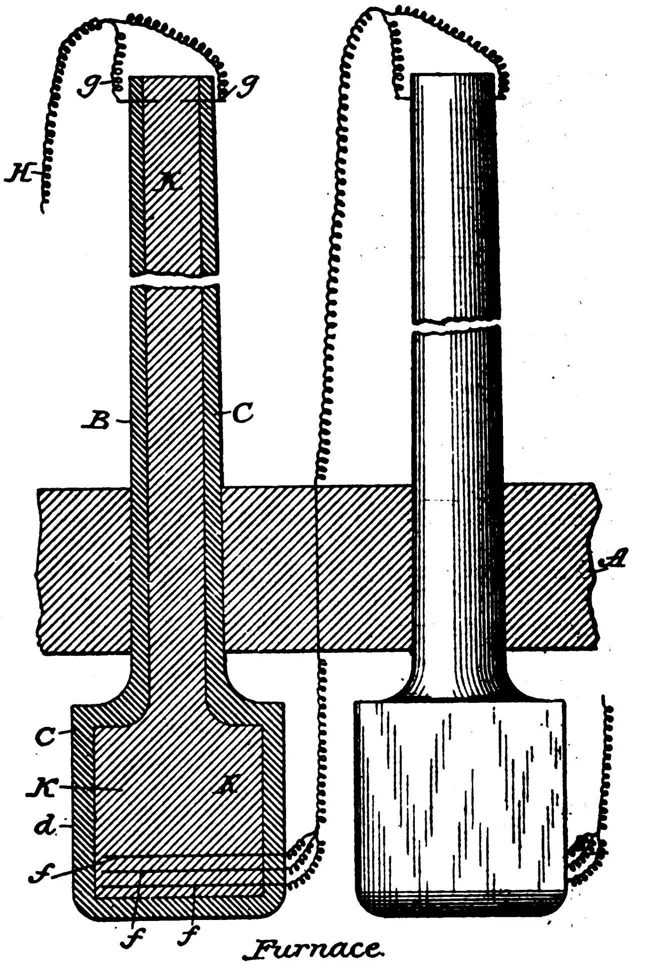
One of the obstacles encountered in generating electricity by means of heat is found in the frailty and instability of the elements necessary in the construction of a thermal battery and in the destruction incident to their exposure to the high temperature of the furnace.

To avoid this difficulty Mr. John Edelkamp, of this city, has devised an arrangement in which that part of the element exposed to the action of the heat is protected. The result of this is that the thermo-element, it is claimed, can be exposed to much higher heat than has heretofore been deemed desirable.

This improvement has been carried out in the manner illustrated in the accompanying engraving, which shows two elements in perspective and in sectional view respectively.

The elements B B, it will be noted, are supported in the wall so that one end of each is fully exposed to the heat of the furnace and the opposite end is left projecting outward to such a distance as will permit it to be kept comparatively cool by extraneous influences.

The elements are each constructed of an outer casing C, of fire-clay and have an enlarged base *d*, rectangular in form, and an extended cylindrical neck projecting centrally from one side, as shown in the engraving. Through the walls of this casing, near the opposite extreme ends, a series of electrode-wires *f f f* and *g g* are inserted, from opposite sides, which project nearly to the centre of the casing; the several wires thus projecting through the wall into the casing are united at each end and connected to the single conducting-wires H, by which the circuit is completed. These electrode and conducting-wires are made either of copper or of an alloy of nickel and copper.



Edelkamp's Thermo-Electric Battery.

The interior of the casing C is completely filled to its extreme outer end with an alloy K, of antimony and zinc, to which cadmium has been added.

It will be noted that only one alloy is employed for the generation of current, the difference of temperature between the two extremities of the piece being depended upon for the development of the difference of potential. The cool outer extremities of each element, is the positive and the heated end the negative pole.

. . . I think the secret of illumination by incandescent electric light is the fact of the distribution of that light. It is hung around in different parts of the room and distributed thoroughly. The light from a chandelier emanates from one point, and the walls of a room, and every place where you look for the effect don't seem to have the light cast equally; at the chandelier there is an excess of light.—*C. H. Evans.*

AN ELECTRIC WIRE COVERING MACHINE.

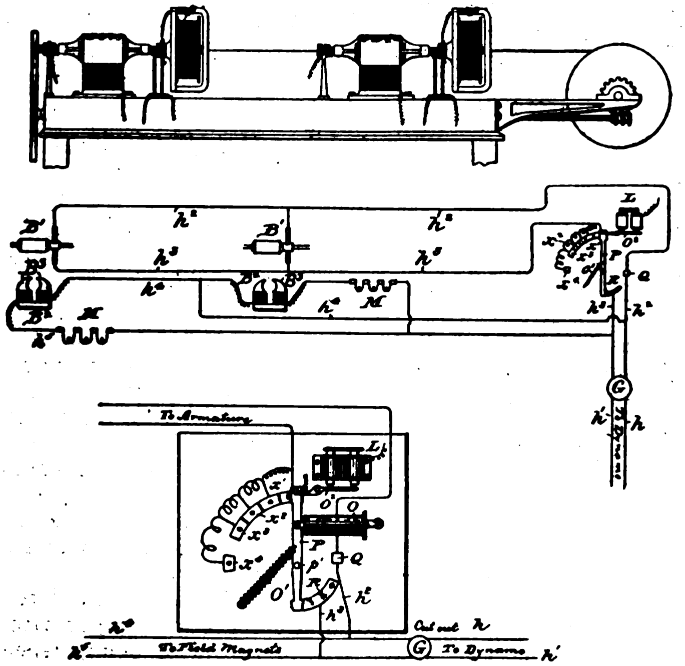
The wonderful adaptability of the electric motor for the direct application of power without the use of intermediate gearing is being recognized more and more every day, with the result that hardly a week passes but some old form of machine is being remodeled to take advantage of this fact. Among the recent applications of this nature is a wire covering machine, the invention of Messrs. Frank E. Davis, of Boston, and John Scott, Jr., of Plymouth, Mass., a general view of which is shown in the accompanying engraving, Fig. 1. The winder, as will be seen, consists of two covering heads and a feed drum. Both winding heads are driven direct by motors, and provision is made for the immediate stopping of the machines on the breaking of the current thread, by the rupture of the current.

In order to secure an even winding of the covering it is, of course, necessary that both winding heads should run at exactly the same speed, and to effect this a special arrangement of circuits and connections has been adopted, which will be understood by a reference to Fig. 2.

As shown, the field magnets of the two motors are arranged in multiple arc, and the current is carried to both armatures of the motors by the circuit h^2 h^3, which is separate from the field magnet circuit.

By arranging both the armatures in the same circuit their rotation at the same speed is secured. If one armature tends to run faster than the other, the first will become practically a generator to the second and supply it with current to accelerate its speed, at the same time the extra effort exhausting its tendency to run faster.

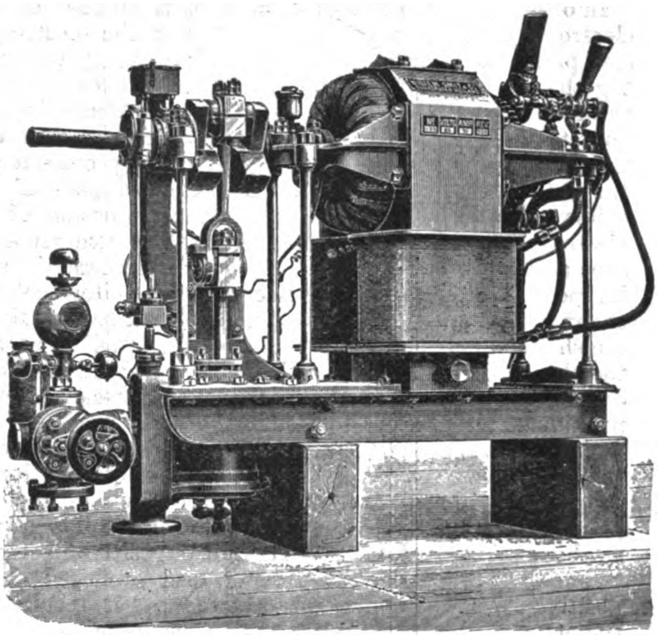
For the purpose of stopping the machines on the breaking of a thread the device shown in Fig. 3 is employed. In this, the upper end of the switch-lever P, when released electrically by the rupture of the thread, is thrown by the spring O′ toward the left, bringing its end successively in contact with the contact-blocks of the resistances x' x^2 x^3, its lower end remaining in contact with the arc R. The effect of this movement is gradually to increase the resistance of the armature-circuit, and thereby reduce the speed of the motor. The further movement of the switch-lever P moves the upper end of the lever off the contact-blocks of the resistance x^3, and at the same time moves the lower end of the lever off the arc R, thus breaking the circuit. The final movement of lever P brings its upper end onto the contact-block of resistance x^4, and at the same time brings its lower end onto the contact-block Q, and closes the armature-circuit on the resistances x' x^2 x^3 x^4. It will thus be evident that the action of the switch-lever when released is to successively insert resistances in the armature-circuit, break the circuit, and short-circuit the armatures on resistance.



Figs. 1, 2 and 3.—A New Electric Wire Covering Machine.

THE SMIT COMBINED ENGINE AND DYNAMO.[1]

Messrs. Smit, of Slikkerveer, Holland, have brought out a neat combination engine and dynamo lighting an arc light projector at sea. It is designed with a view of having as little weight as possible. The output is 65 volts and 70 amperes, as required for the Dutch Navy's torpedo boat "Cerberus." In order to reduce the weight to the lowest possible limit, as demanded by the naval authorities, Messrs. Smit have used an open engine instead of the closed-in type, and thus have decreased efficiency, durability, and freedom from breakdown. The armature is Gramme wound with 3.5 mm. wire. The speed is 450 revolutions per minute, and is controlled by an electromagnetic governor interposed in the shunt circuit.



The Smit Combined Engine and Dynamo.

The engine has 4 in. cylinder, by 5 in. stroke, and works with 100 lb. to 150 lb. pressure of steam. The engine and dynamo together weigh 840 lb., and the 20 in. projector to match weighs 520 lb., or 1,360 lb., total weight. The outside dimensions are 3 ft. 9 in. long, 2 ft. 6in. high, and 1 ft. 5½ in. broad.

THE STEPANOFF ELECTRIC BLEACHING PROCESS.

In the method of electric bleaching devised by M. Stepanoff, common sea salt is employed instead of chloride of magnesium, as in the Hermite process. A solution of sea salt is pumped into an "electrolyser," having lead and platinum electrodes, and is there submitted to electrolytic action; after which, the electrolysed solution is pumped into the bleaching tanks. With his present apparatus M. Stepanoff uses 40 amperes and 45 volts, and is able to furnish 300 litres (66 gallons) of chloruretted solution per hour. Although matters may be so arranged that a 1 6 per cent. solution can be obtained, M. Stepanoff does not, as a rule, employ a solution containing more than seven per cent. of chlorine. The substitution of lead for zinc electrodes in the electrolysers is claimed as an improvement.

... There are endless patterns of dynamos in the market, but all those of the best makers give approximately the same efficiency and possess the same qualities generally.—*Sir D. Salomons.*

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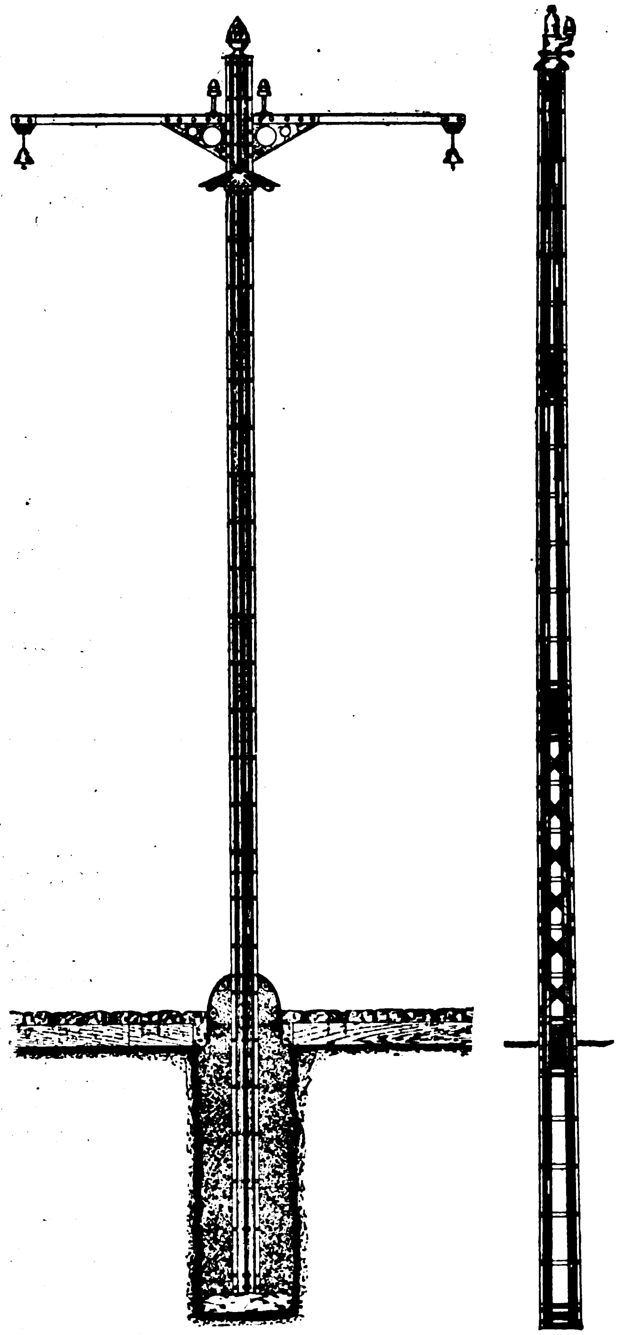
[1] *Industries.*

THE MILLIKEN ELECTRIC RAILWAY POLE.

The overhead system of operating electric railways has made such rapid strides and presents such unquestionable advantages, that it is fair to assume that it will for a long time continue to be the standard method of conducting the current to electric street cars. One of the most important elements entering into the maintenance of the integrity of the overhead construction, is the pole from which the wires are suspended, either directly, or by span wires; and past experience has shown that lack of strength and proper methods of erection soon lead to irregularity in the lining of the conductor with consequent ill effect upon the running of the trolley. To this is added an unsightly appearance of the line which frequently gives rise to complaints.



Figs. 1 and 3.— The Milliken Electric Railway Pole.

To remove these objections, iron poles have been largely employed in place of the wooden ones, and with marked success. Heretofore, solid iron poles have been generally used, but an interesting departure in this direction has recently been brought out in the shape of an open wrought iron pole, for which a number of advantages are claimed.

The Milliken pole, as it is called, which is now being introduced by Mr. Lemuel W. Serrell, of this city, is formed of four sections of iron of the "Phœnix" shape, riveted together with tie plates, placed equidistant, with latticework inserted at the point of greatest strain. This is clearly shown in the accompanying engravings, Figs. 1 and 2, which show respectively an elevation and transverse section of the centre-pole type adapted for double track roads. As will be seen, a taper is given in the direction of greatest strain, making a pole having the greatest possible strength for the weight of material used. These poles are very light and durable, and, being open, present a very pleasing appearance to the eye, while the inside can be painted and preserved indefinitely from the action of the air.

This type of pole was recently tested at Post & McCord's Bridge Works in Brooklyn, and the pull at the top measured by a Fairbanks dynamometer; with a pull of 800 lbs., the deflection was less than four inches. The deflection took place in a regular curve, and showed no irregular bending at any point. A block and tackle was then attached at the upper end of the pole and the building, and eight men pulled on the rope; unfortunately, the concrete was not quite dry, and the pole moved bodily in the earth, the top being moved some six feet towards the building, breaking the concrete up in lumps. When taken out of the ground the permanent set was so small that the pole was readily straightened in jaws.

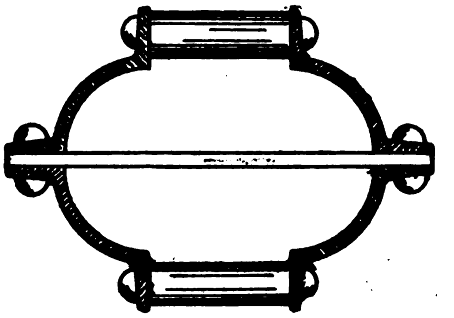


Fig. 2.—Transverse Section of Pole.

The centre-pole for use between the tracks has its longest diameter parallel with the rails, and, when arranged with an ornamental top and lamps, makes a very artistic pole. The cross-arms can be made separate from the pole, if so desired, for shipment, and bolted on after it is set in the ground. A cast iron bumper to keep wagon wheels from striking the pole is also provided at the bottom. This is made in two parts, bolted together on the inside, and can be filled with concrete, as shown in the engraving.

At present a number of these poles are being made for the Jersey City and Bergen Railway Co., who recently contracted for the equipment of their lines with the Thomson-Houston system.

The engraving, Fig. 3, shows the same style of construction as employed in the pole to be used in connection with span wires.

PROTECTION OF SUBMARINE CABLES.

The text of the convention for the protection of submarine cables, held in Paris, has just been published as a parliamentary paper. It is a punishable offence to willfully damage a cable to the interruption of telegraphic communications; but this clause (No. 2) does not apply to those who injure it with the object of saving life or their ship. If the owner of a cable damages another one he must repair it, and that without prejudicing a penal action which may be instituted. It is compulsory for all vessels and fishing boats to keep a mile away from any ship engaged in laying a cable. Owners of vessels who can prove that they have sacrificed gearing or anchors in order not to injure cables can recover the amount from the owner of the cable if applying at once. The treaty, which is an international one, and applies to the colonies, remains in force for five years, and is to be renewed yearly.

THE CLARK AUTOMATIC SAFETY DEVICE.

In operating series-wound dynamos, if the line-wire is broken by accident or design, the flow of current being interrupted, the electromotive force falls to a greater or less degree, depending upon the power of the dynamo, and the residual magnetism of its field-magnet cores. The electromotive force which still exists, however, may be sufficient in the case of large dynamos to give dangerous shocks to persons or animals that may accidentally come in contact with the broken wires. Should the broken wires, in falling, make contact with any other good conductor—such as another wire, an awning-frame, or metallic roof—this conductor becomes part of the circuit, which, being thus completed, permits the dynamo at once to resume its action, rendering the accidental portion of the circuit dangerous to persons coming in contact with it, as well as being liable to cause fires by reason of the faulty nature of the contacts with the broken ends of wire. Another danger from such an accident is to the dynamo itself. At the moment of interruption of the current, the lamps or motors in circuit at once assume their condition of lowest resistance. If, then, the circuit is suddenly closed, the dynamo resumes its action instantly, and the result is an abnormal rush of current, which may injure the dynamo. This is particularly the case if an automatic regulator is used with the machine. Such regulators operate, as a rule, to maintain a constant current through a variable resistance; when, as in case of a broken line, the resistance becomes very great or infinite, the regulator in the effort to maintain the current at once applies the greatest electromotive force the machine can produce, thus increasing the dangers from the broken wires.

To obviate all these elements of danger in connection with high tension circuits, Mr. E. P. Clark, electrician of the Clark Electric Co., of this city, has recently patented and brought out a safety device, which has already been mentioned in our columns, and which we are now enabled to illustrate.

The Clark safety device is constructed in various forms to adapt it for series or shunt arc machines, and also for alternating dynamos. Our engraving, Fig. 1, shows the apparatus as designed for series wound arc machines, and the diagrams Figs. 2 and 3, show very clearly the manner in which it acts to render the line safe the instant a break occurs in the circuit.

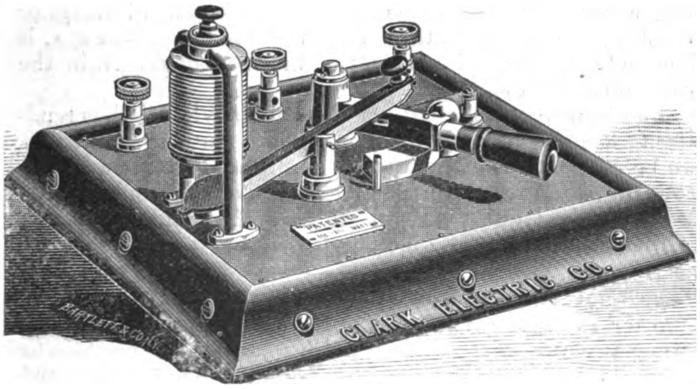
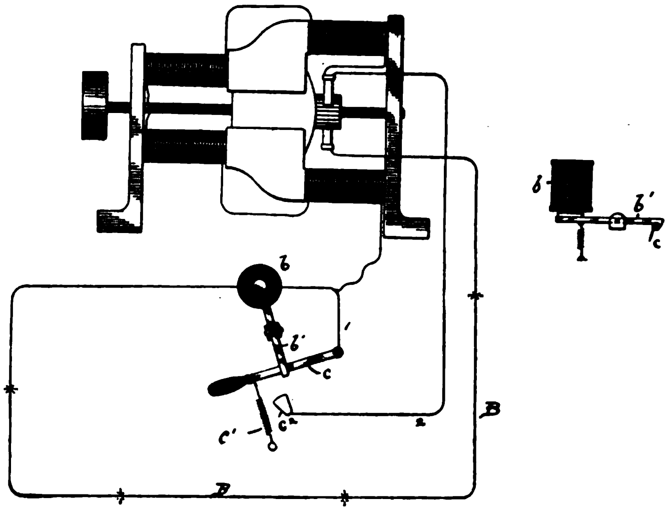

CLARK ELECTRIC CO.

Fig. 1.—The Clark Automatic Safety Device.

As will be seen the small electro magnet *b*, is located in the main circuit, and, as long as the current flows, its armature lever, *b*, is held firmly up, locking the switch in position, and permitting the current to pass to the line. Should the line break or be cut by firemen or others, the current ceases instantly, and the armature of the electro magnet *b* falls, releasing the switch, which flies back under the influence of its spring *c*. The result of this movement of the switch is to close a short circuit, 1, 2, across the field coils of the dynamo, thus depriving them of all current, and of course rendering the dynamo powerless.

The hard rubber knob shown at the top of the magnet in Fig. 1, is attached to a rod reaching through the magnet core, and is used as a convenient means of throwing the dynamo out of action at any time; it being only necessary to force the armature away from the magnet, by a light tap on the knob, to put the machine quickly out of action without any strains or shocks.

Another valuable feature of this device is, that it works automatically every time the dynamo is stopped or put out of action, and it must be re-set by hand, as the last thing to be done when starting the machine on its load. This, in a measure, insures its proper inspection and action, when it is called upon; for should it get damaged or out of order the attention of the person in charge is called to it, as he must operate it every time in starting up.



Figs. 2 and 3.—The Clark Automatic Safety Device.

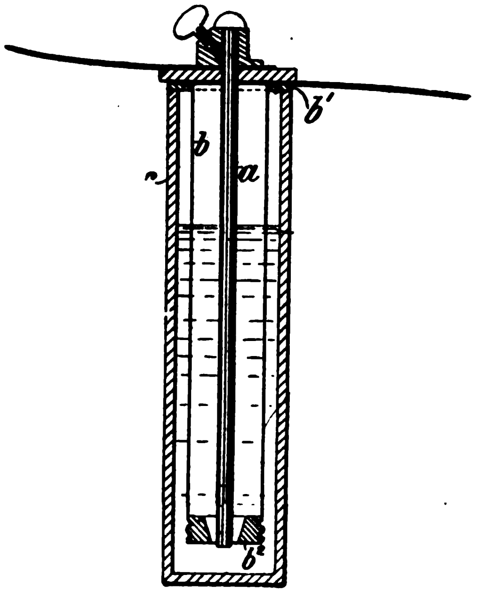
The safety devices for shunt wound dynamos and for alternators vary somewhat from the foregoing description in their electrical details, but the device described above embodies the general plan on which all are constructed; the object in all varieties of the device being to put the machine out of action instantly upon the breaking of the line, and to accomplish this with certainty, and without endangering the machine in any way.

THE RENARD CHLOROCHROMIC BATTERY.

The art of ballooning has in recent years undergone considerable progress due in a large part to the application of the electric motor for the propulsion of balloons, and coincident therewith efforts have constantly been made to provide as powerful a battery as possible combined with the least weight. On account of the latter requirement storage batteries have not been applied for this purpose, but, attention has been given principally to the primary battery. Among those who have devoted considerable time to this work is Major Renard, chief of the Ballooning Department of the French Army, some of whose work in the past at the Meudon station near Paris, may already be known to our readers. The results of Major Renard's work in the production of a light powerful battery, led him to the employment of a battery which has just been patented in this country and which he claims is six times as powerful as the ordinary bichromate cell of the same weight. The improvements made by Major Renard, comprise not only the employment of a new exciting liquid but in addition a novel form of cell.

The solution employed consists of a chlorochromic mixture, obtained by dissolving pure crystallized chromic acid direct in dilute hydrochloric acid. The proportions giving good results are as follows: Hydrochloric acid at 11° Beaumé, 200 cub. centimetres; and pure crystallized chromic acid from 40 to 100 grammes.

The element employed by M. Renard is shown in the accompanying engraving. It consists of a slender zinc pencil *a*, and for the particular purpose for which the battery is designed, the dimensions are so calculated that the zinc is entirely dissolved when the liquid is exhausted, so that each new charge of liquid shall correspond with the renewal of the zinc pencil. This arrangement has for its object to place in the battery only the exact weight of zinc necessary for its working, and consequently to reduce to a minimum the weight and volume.



RENARD'S CHLOROCHROMIC BATTERY.

Another feature of the cell is the employment of a negative electrode *b*, consisting of a sheet of silver covered by lamination on both surfaces with a very thin coating of platinum. There is thus obtained a conductor possessing the conducting power of silver with the inalterability of platinum, the cost of which, moreover, is not much more than if it were made entirely of silver.

The long tubular form of the elements is favorable to the cooling down of the same, which is necessary in this battery, as the activity is very great and the exciting-fluid might attain too high a temperature if the cells did not present a considerable external surface in proportion to their volume.

FIXING IRON FILING CURVES.

In a recent number of *La Lumière Electrique* is described a new method of fixing iron filing-curves, due to M. Korobow. The usual method of fixture, on a plate of glass covered with gum by passing a jet of vapor over the surface, is objected to on account of needless cost and the unsatisfactory nature of the results obtained. The photogaphic method is, moreover, difficult, and only possible to a comparatively few. M. Mach's process consists in mixing iron filings with aniline powder and spreading over the surface. The figure is formed in the usual way, the iron filings are removed by means of a magnet, and the aniline remains fixed to the paper. The figures obtained are, however, seldom sharply defined. In Mr. Korobow's process a plate of glass is warmed on the smooth upper surface of a shallow iron dish containing water raised to a suitable temperature by means of a spirit lamp. A piece of paraffin is placed on the glass, and in the course of three or four minutes spreads itself evenly in a thin layer over the surface The glass plate is removed, the surplus paraffin running off. The image is formed with iron filings on the cooled paraffin, which does not adhere to the iron; so that, if the image is unsatisfactory, the filings may be removed and a new figure taken. To fix the curves the plate of glass is again placed on the warming stove. Finally, the surface of the paraffin is covered with white paint, so that the curves appear black on a white ground. Very well-defined figures may be thus obtained. A similar, though much simpler, process consists in covering one surface of stiff white paper with a layer of paraffin, by warming over an iron plate, spreading the filings over the cooled surface, and fixing them with a hot iron or a gas flame.

THE SEYMOUR UNIVERSAL CARBON HOLDER.

THE constant handling which the carbon holders in an arc lamp are subjected to, together with the wear which the deterioration which they undergo makes their renewal from time to time necessary. To avoid this as far as possible and also with the object of overcoming some of the troubles inherent in this important part of the lamp, Mr. A. P. Seymour, of Syracuse, N. Y., has devised a new form of holder both for the upper and lower carbon. The former, which is illustrated in the accompanying engraving, Fig. 1, is adapted to hold either a $\frac{7}{16}$ or $\frac{1}{2}$ inch carbon, and by providing the slot A the holder can adjust itself to any variation of the screw thread on the carbon rod. The act of clamping the carbon tightens the holder on the rod, preventing all lateral motion of the carbon and also the shaking of the holder from the rod by the wind.

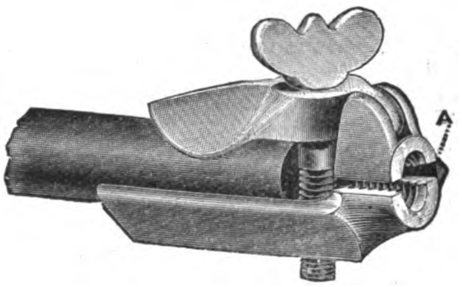


FIG. 1.—SEYMOUR'S ARC CARBON HOLDER.

The holder designed to keep the lower carbon rod in position, is shown in Fig. 2. It holds the carbon firmly with a very slight pressure of the screw A, as the lever B acts like a cam, and tends to wedge the carbon when it drops or is pushed down. The thread of the clamping screw A, is completely protected so that the melted copper from the carbon cannot clog it.

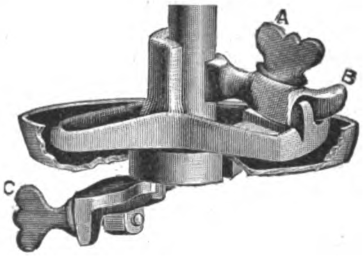


FIG. 2.—SEYMOUR'S ARC CARBON HOLDER.

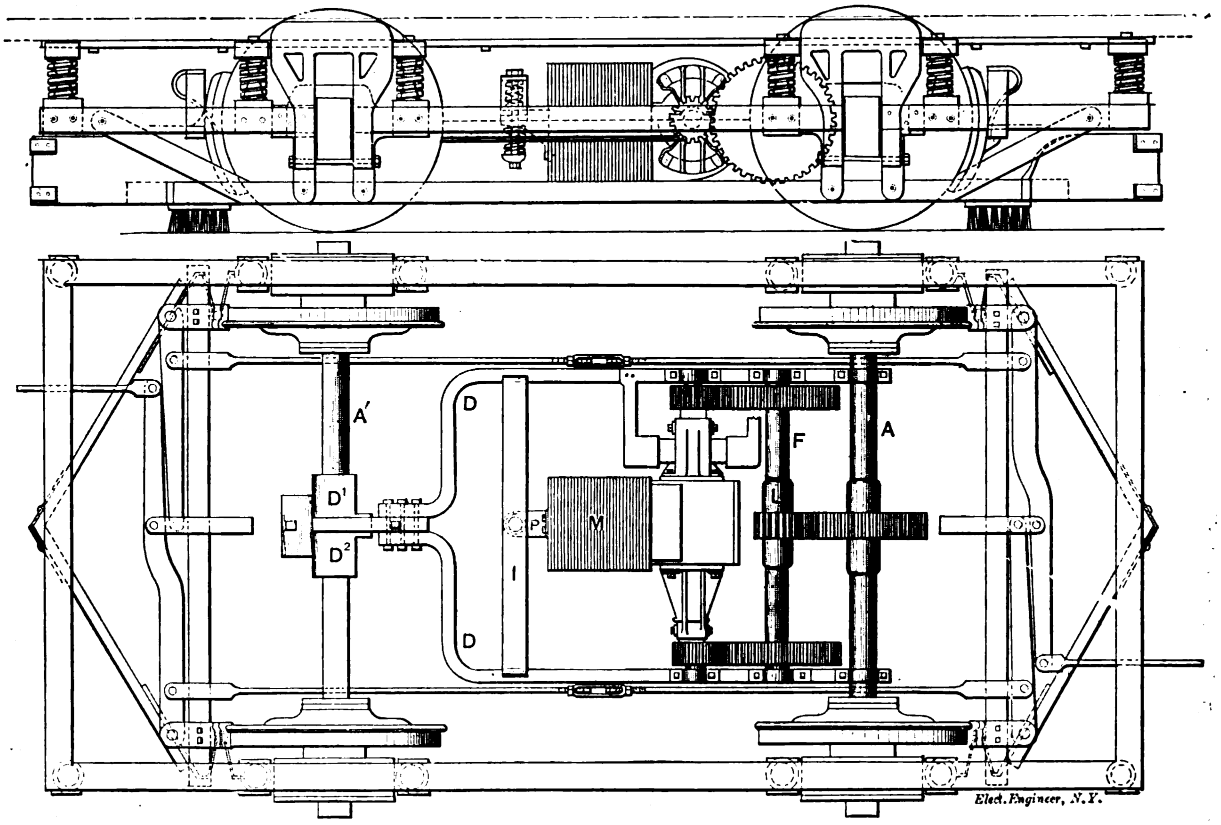
The bearing of the body of the holder is large, thus tending to keep the carbon upright. The adjusting screw C, is on the underside of the dust pan of the lamp, and therefore protected from dust or melted copper from the carbons, and can easily be got at and the holder adjusted without removing the globe.

THE REIGNIER AND BARY DYNAMO.

At the last *séance* of the Société des Électriciens, M. Reignier gave some interesting particulars with regard to the machine he is constructing in conjunction with M. Bary. MM. Reignier and Bary have made a great point of reducing the resistance of the magnetic circuit. By diminishing this they have been able to employ a very small magneto-motive force, and consequently to greatly diminish the weight of copper; and the total weight of machine for a given output is, therefore, at the same time considerably reduced. The method adapted by M. Reignier for reducing the resistance of the air-gap consists in winding the armature with a conductor composed largely of iron. The machine is of the ring type. The armature conductors are composed, and consist of a strip of copper, sandwiched between two strips of iron, and kept together by the insulating covering. But as in a ring the external surface is larger than the internal surface, the strips of iron are only on the outside. The machine, which has actually been constructed, has an output of 10.5 kilowatts (70 volts and 150 amperes) at a peripheral speed of 10 metres per second (33 feet per second), and at an angular velocity of 1,800 revolutions perminute. The machine weighs 263 kilogrammes (580 lbs.) Its output for weight is thus 40 watts per kilogramme (18.2 watts per lb.) The electrical efficiency of the machine is 94 per cent. and the commercial 90 per cent.

THE NEW PECKHAM ELECTRIC CAR TRUCK.

When electric railroading first occupied the attention of electrical engineers their work was in a large measure designed to conform as nearly as possible to the methods of railroad transportation in vogue at that time, and as a result started out with the idea of employing a locomotive having a single motor as the driving power. Later developments, however, saw a change from this type to the electric car in which two motors were employed, each geared to one of the axles. Although this may be said to be the standard car of to-day, signs are not wanting that the near future will develop a decided departure which will in all probability lead to the employment of a single motor to each car, geared to one or both axles, together with various modifications in the style of the truck and attachment of the motor to the axles.



Figs. 1 and 2.—The New Peckham Electric Car Truck.

Mr. Edgar Peckham, of this city, who has given considable attention to this branch of electric railroading, and who has designed numerous improvements which are already well known and in use, has recently brought out an improved electric car truck which presents a number of novel features both of arrangement and construction. Mr. Peckham's object in this new design has been, among others, to secure a flexible connection between the truck frame and the supporting frame of the motor by which torsional strain is prevented when the cars are traveling on a curve, so that the motor and its gearing are relieved from all liability of displacement and consequent injury. At the same time the design is such as to bring the weight of the single motor employed more nearly in the longitudinal centre of the truck, so as to prevent the crowding of the motor proper with its gearing and the counter shaft. This is clearly indicated in the accompanying engravings, Figs. 1 and 2, which represent respectively a plan and elevation of the new Peckham truck.

As will be seen, both ends of the armature shaft are supported in bearings on the motor frame D D, and it is geared near both of its ends to the counter shaft F. This shaft again is geared centrally between the side bars of the motor supporting frame to the axles of the driving wheel A, in contradistinction to the usual method of connection, which is situated at one end only. This construction is claimed to avoid all disarrangement by the vibration of the motor and truck, and also insures regularity of movement with the cars.

The curved supporting frame D D is applied to the beam D^1 which projects forward and is supported on the enlarged surface of the box D^2, which is applied to the axle A^1. The purpose of making the top of the surface of box D^2 of considerable width transversely is to afford a sufficient bearing in the spring end of the beam D^1 when the motor supporting frame D D is being subjected to torsional strain. The box D^2, while fixed to the axle A^1, is flexibly connected to the beam D^1, so that the motor-supporting frame is practically swung on a pivot at its rear end, and can thus assume the vibratory and oscillatory movements of the truck.

It will also be noted that the field magnets of the motor M, are so mounted upon the supporting frame D D, as to bring them practically in the centre of the truck frame longitudinally and transversely. The advantage of this arrangement is that the weight of the motor is more evenly distributed over the truck frame. To effect this arrangement the heel of the magnet is provided with a tail piece P, which is supported at the rear of the armature shaft and on the opposite side of the counter shaft. This tail piece, P, is supported between springs which permit of the magnets yielding vertically. By thus supporting the heel of the magnet in the position shown, the space between the armature shaft and driving wheel A, is not unduly crowded, so that the counter shaft and the various gear wheels can more easily be reached when changes and repairs become necessary.

It will also be noticed that the space gained by this arrangement permits of the enlargement of the counter shaft and driving axle A, at the point where the gears are attached, so that both these shafts are additionally strengthened at the point where the power is applied. The arrangements here adopted are claimed by Mr. Peckham, to overcome a number of disadvantages which exist in the present style of truck in use.

ON THE SPECIFIC RESISTANCE OF METALS AND ALLOYS.

BY GEORGE B. PRESCOTT, JR.

THAT there exists at the present time much uncertainty respecting the absolute resistance of pure metals and their alloys is generally well known, and may easily be ascertained by any one who chooses to compare the tables to be found in the current electrical text books. It is evident, furthermore, from the correspondence columns of the electrical journals, that this condition of affairs is a source of some confusion and annoyance to electrical manufacturers and artisans, who understand the importance of using metals of the highest conductivity in the construction of their apparatus and distributing systems. To explain the cause of this disagreement and to present, if possible, some reliable evidence respecting the best authenticated, and, therefore, most trustworthy figures for the specific resistance of the more commonly used metals and alloys, is the purpose of this article.

From a scientific point of view, it is doubtful whether knowledge of the mean specific resistance of the pure metals and their alloys would be considered of much value, as the electrical properties of any substance can be positively expressed in terms of its absolute specific resistance or conductivity, without reference to any arbitrary standard, such as the average conductivity of a pure metal. Dr. Matthiessen has demonstrated, moreover, that the values for the specific resistance of even chemically pure electrotype copper, when determined with ordinary care, differ for different specimens by as much as 1.6 per cent., and other metals differ to a greater or less extent. This he attributes to the fact that the molecular structure of even pure metals is not the same for different specimens of the same kind of metal. Where great accuracy is desired, therefore, all of the physical qualities of the particular samples experimented upon must be ascertained and taken into account.

Nevertheless it is the common commercial practice, dictated no doubt, by considerations of practical convenience, to indicate the quality of wires for electrical uses in terms of their conductivity as compared with that of a similar wire of pure metal of the same kind; and if such standards of reference are to be employed at all, it is certainly desirable that they should agree. Now, as the standards of conductivity which circulate in the commercial world, have been derived from the figures for the resistance of metals as given in the electrical text-books, which differ to a marked extent, they also fail to harmonize, and the confusion alluded to results.

So far as the writer, who has taken some pains in the matter, has been able to discover, the experiments of Dr. Matthiessen in connection with the work of his collegues, Messrs. Von Bose, Vogt and Hockin, on the specific resistance and relative conductivity of the metals and alloys, and on the effect of temperature on their conductivities, have been generally accepted as authoritative, and the values determined by them universally adopted as the basis for tables of resistance, and formulæ for temperature corrections. No less an authority than Clerk-Maxwell says in his "Electricity and Magnetism," that there is no part of electrical research in which more numerous or more accurate experiments have been made than in the determination of the resistance of metals, and that the electrical properties of metals and alloys have been studied with great care by Messrs. Matthiessen, Vogt and Hockin.

As the results of Dr. Matthiessen's researches supplied the data from which the British Association Committee determined upon the practical standard of resistance, and as the first comprehensive tabulation of these results by Professor Fleeming Jenkin, a member of that committee, appeared in a volume of their reports,[1] it is reasonable to presume that the figures given therein, and in Matthiessen's published researches, are the standards commonly referred to. This being the case, the question naturally suggests itself, Why should tabulations based on figures derived from the same experiments, differ so widely when made by different persons?

In a previous article[2] the writer, in referring to the marked discordance between the values for the specific resistance of copper, given in various electrical text-books, called attention to the fact that one cause for this lack of agreement could be traced directly to the reports of the British Association Committee referred to above. In the third report, 1864, there appear two different figures from which the specific resistance of hard and soft copper may be deduced, and both have been quoted as standards in numerous instances. The first is given by Dr. Matthiessen and Mr. Hockin, in a table in appendix C, to the 1864 report, and states that :—

The approximate resistance of a metre-gramme of pure hard-drawn copper at O° C. = 0.1469 *B. A. unit.*

The second appears in the body of the report in a table showing the approximate relative values of various units of electrical resistance, and states that :

The resistance of a Matthiessen unit, viz., one English standard mile of pure annealed copper wire $\frac{1}{16}$ *inch diameter at* 15.5° *C.* = 13.59 *B. A. units.*

If these two values are reduced for similar dimensions and temperature, and due allowance be made for the difference between the conducting powers of hard-drawn and annealed copper, a considerable disagreement will still be found to exist between them, and this difference is the source of error referred to in the article mentioned.

It is here essential to note the fact that while the first of these figures specifies the resistance of a given weight and length of copper, the second specifies the resistance of a given length and cross-section of copper. In other words one expresses the dimensions in terms of length and mass, the other in terms of volume. Now in order to deduce the resistance of a material per unit volume, from its known resistance per unit length and mass, the specific gravity of the material must be determined. This requirement appears to have been a prolific source of the disagreements as to the resistance of metals, particularly in the case of mercury, in terms of the specific resistance of which the legal ohm is defined; for it will appear that various writers have employed different specific gravities in tabulating Dr. Matthiessen's observations.

Although for commercial purposes it is found to be more convenient to express the resistance of materials in terms of length and cross-section, all of Dr. Matthiessen's later measurements were made from given lengths and weights of the materials he experimented on, because he found it to be impossible to measure the diameter of a small wire with the accuracy with which the weight can be determined. Moreover, the cross-section of a wire is not generally a circle, and the mean diameter varies slightly from point to point, however carefully it may be drawn.

A great oversight was made by Dr. Matthiessen in not observing the specific gravity of each wire experimented on, so that the results could be compared with former experiments. On this subject he says in the B. A. report :

> "*This omission was first made because it was thought that the results of former experiments could be used; but after several measurements had been made it was found that the values of the specific gravity of wires of the same metal, given by different observers, varied so much that it was impossible to find the resistance of a wire of a metal of which the length and sectional area are known, from the resistance of a wire of which the length and weight are known, without taking the specific gravity of the wire actually experimented on.*"

The system of measuring the conducting power of substances by comparison with that of some other bodies such as silver or mercury, which Dr. Matthiessen unfortunately employed, although he frequently pointed out the discrepancies thus produced, has also been the source of much confusion to those who have since undertaken to tabulate his results in a more convenient form.

In attempting to explain how the resistance tables in some of the more frequently consulted text-books come to differ from each other, although their constants have ultimately been derived from the same source, it will perhaps be well to first explain what is meant by absolute and specific resistance or conductivity. The word "absolute" is only used in contradistinction to the word "relative," and by no means implies that the measurements or units are absolutely correct, but that the measurement is made by reference to fundamental units of another kind, and not by a simple comparison with an arbitrary quantity of the same kind.

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[1] *Reports of the British Association Committee on Electrical Standards.* Edited by Fleeming Jenkin, London, 1873.

[2] THE ELECTRICAL ENGINEER, June, 1888.

The specific resistance of a material referred to unit mass and length may be defined as the resistance of the unit mass formed into a conductor of unit length and of uniform section. Thus the specific resistance of a metal in the C. G. S. system is the resistance of a wire of that metal one centimetre long and weighing one gramme. The specific resistance of a material referred to unit volume may be defined as the resistance between opposite faces of a cubic centimetre of the material. Specific conducting power or conductivity are terms employed to express the reciprocals of specific resistance as referred either to unit mass and length or to unit volume. Now, as the unit of weight in the C. G. S. system, the gramme, is the weight of a cubic centimetre of water at maximum density, and as the density of a cubic centimetre of water is also taken as unity, it follows that:

$$\text{Resistance of unit volume} = \frac{\text{Resistance of unit length and mass.}}{\text{Specific gravity.}}$$

Turning now to the volume of B. A. Reports in expectation of finding the required data, one is surprised to learn that, so far as Dr. Matthiessen's work is concerned, it relates almost exclusively to experiments on the effects of age, use and variations of temperature on the resistance of numerous alloys. Only one mention is made of the resistance of metals, with the exception of the table, already referred to, giving the values of various units of electrical resistance, in which the resistance of copper and mercury incidentally occurs. There are, however, numerous references to previous experiments made by Dr. Matthiessen, from which it appears that the results of these earlier determinations were accepted by the committee. These references[1] together with some obtained from other sources have been freely consulted, and it is believed that they cover the ground of Matthiessen's published researches.

In Table I., will be found the values for the resistance of some of the metals, as given by Dr. Matthiessen in the B. A. Report. Although not stated in the report, it has been learned from other records that the figures given are for the temperature 0° C., and that the mercury is liquid, the lead pressed, and the other wires hard drawn.

TABLE I.

Approximate Resistance of a Metre-Gramme of the Different Metals in Terms of the B. A. Unit.

From B. A. Rep., 1864

Metals	Resistance.
Copper	0.1469
Silver	0.1682
Gold	0.4150
Gold-silver alloy	1.668
Lead	2.257
Mercury	13.06

In the latter part of this volume of reports, however, there are reprinted several Cantor lectures by Professor Jenkin, which deal chiefly with the results of the committee's labors, and their appearance in this volume gives them authoritative value. One of these lectures contains a table of the specific resistance of metals and alloys based on Dr. Matthiessen's experiments, the resistances being calculated for a metre-gramme, a metre-millimetre, a foot-grain and a foot-mil of the various metals. As this table is frequently referred to as the authority for Matthiessen's figures, it will be interesting to note the means resorted to in compiling it. The numbers which appear in the metre-gramme and metre-millimetre columns of this table are given in Table II., together with the corresponding specific gravities which have been calculated from the numbers in those columns; also a cubic centimetre column taken from the same table in a later edition of Professor Jenkin's *Electricity and Magnetism.*

TABLE II.

Specific Resistance in B. A. Units of Metals and Alloys at 0° C. Calculated from Dr. Matthiessen's Experiments.

From B. A. Rep., 1873 and Jenkin's *Electricity and Magnetism.*

Name of Metals.	Specific gravity.	Resistance of a wire 1 metre long, weigh'g 1 gramme.	Resistance of a wire 1 metre long, 1 millimetre diameter.	Resistance between opposite sides of a cubic centimetre.
Silver annealed	10.15	0.1544	0.01937	1521
" hard drawn	10.17	0.1680	0.02103	1652
Copper, annealed	8.91	0.1440	0.02057	1616
" hard drawn	8.89	0.1469	0.02104	1652
Gold, annealed	19.603	0.4080	0.02650	2081
" hard drawn	19.592	0.4150	0.02697	2118
Aluminium, annealed	2.572	0.0757	0.03751	2945
Zinc, pressed	7.148	0.4067	0.07244	5689
Platinum, annealed	21.4	1.96	0.1166	9158
Iron, annealed	7.79	0.7654	0.1251	9825
Nickel, annealed	8.5	1.071	0.1604	12600
Tin, pressed	7.29	0.9738	0.1701	13360
Lead, pressed	11.376	2.257	0.2526	19850
Antimony, pressed	6.716	2.411	0.4571	35900
Bismuth, pressed	9.823	13.03	1.689	132700
Mercury, liquid	13.578	13.06	1.2247	99740
[1]Platinum-silver alloy, hard or annealed	12.	2.959	0.3140	24660
[2]German-silver, hard or annealed	8.74	1.85	0.2695	21170
[3]Gold-silver alloy, hard or annealed	15.18	1.668	0.1399	10990

1. Platinum, 2 parts; silver, 1 part.
2. The alloy usually used for resistance coils.
3. Gold, 2 parts; silver, 1 part.

The underlined numbers are the direct observations of Dr. Matthiessen, and it will be observed that they agree with the numbers in Table I, with the exception of a slight difference in the value for silver which is probably due to an error in copying. The method employed in compiling this table is explained in Professor Jenkin's *Electricity and Magnetism*, in which it is reprinted with an additional column showing the resistance of the substances per cubic centimetre. The underlined numbers were first inserted in the metre-gramme column, and the metre-millimetre numbers obtained by taking the value 2.257 for the resistance of a metre-gramme of lead, and calculating the resistance of a metre-millimetre from the specific gravity, 11.376. The other numbers in the latter column were then filled in by making them inversely proportional to the relative conducting powers for equal volumes, as given by Dr. Matthiessen, when hard-drawn silver is 100 and the gold-silver alloy is 15.03. The metre-gramme column was next filled in by calculating the values for zinc, platinum, iron, nickel, tin, antimony, bismuth and mercury, from the metre-millimetre column by their specific gravities, the three alloys from specific gravities given by Dr. Matthiessen, and the soft silver, copper and gold from the ratio of their conducting powers to those of the hard-drawn metals. The figures in the foot-grain, foot-mil and cubic centimetre columns were obtained by comparison from the others.

(*To be continued.*)

A NEW INSULATING COMPOUND.

The large variety of insulating compounds already in existence has recently been increased by another, in which by combining two well-known bodies a material of high insulating properties together with other valuable characteristics is obtained. The new compound which has reecntly been invented and patented by Mr. A. A. Knudson, consists of a mixture of carbolic acid and shellac. The two substances are combined by heating carbolic acid until it boils slowly, and then adding the shellac, or other insulating materials, such as vegetable drying oils, asphalt, resin, etc. The product is a semi-plastic mass remarkably tough and tenacious, which is but little sensitive to extreme changes of temperature, and presents a hard smooth surface. The results obtained with this new compound have already proved very encouraging.

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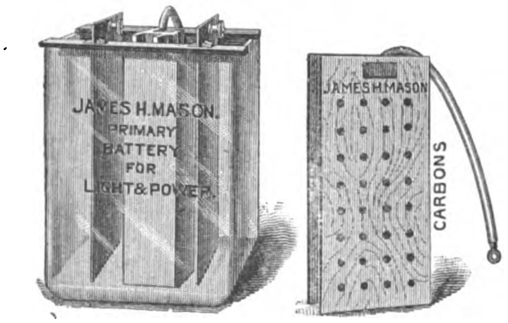
[1] *Philosophical Transactions*, 1858, 1860, 1862, 1863, 1864.
Philosophical Magazine, 1857, 1861, 1862, 1865.
Proc. Royal Society, 1862, 1863.

THE MASON PRIMARY BATTERY.

Although the dynamo has to a very great extent acted to place the primary battery in a position of secondary importance as a source of electrical energy, it cannot be denied that the battery nevertheless still occupies a sphere of some importance, and indeed has a legitimate field of use which it would be folly to ignore. A primary battery possessing merit, therefore, has a fitting place and as such deserves recognition. Thus in many situations where dynamo current is not available a battery can be very well applied for furnishing current to a small number of lights, for the driving of fans or sewing machines or the performance of other light work.

This has been recognized by Mr. James H. Mason, of Brooklyn, who has for some time past devoted his attention to the construction of a reliable primary battery, and one which shall require as little attention as possible. The cells constructed by Mr. Mason vary in size and capacity. One of these known as No. 11 cell is designed for 350 ampere hours with one charge of solution.

The cell, as shown, consists of a glass jar containing a porous cup which is specially prepared and made indestructible. This porous cup is intended to hold the Mason depolarizing solution and in which the carbons are immersed. There are two carbons which are cast together, the carbons being prepared with a special solution, which keeps the metallic parts of the casting always bright and indestructible. A heavy flexible wire is also cast in, the wire being well insulated with rubber and cotton, after which, as an extra protection, it is inserted in a flexible rubber tube. The end of the wire is then well soldered to a special terminal.



THE MASON PRIMARY BATTERY.

These carbons together expose over 300 square inches of surface to the depolarizing solution. On either side of the porous cup two zinc plates are suspended. These plates measure 12 inches long by 8 inches wide and ⅛ inch thick, and jointly expose over 325 square inches of surface to the solution. Polarization does not take place in the cell with this depolarizing solution.

The carbons are perforated with taper holes, measuring one-half inch in diameter at the large end and one-sixteenth of an inch in diameter at the small end. It will readily be seen that this plan exposes a considerable surface of carbon to the solution, while at the same time the small hole allows the solution to flow freely from one side of the plate to the other.

The work which the batteries of Mr. Mason have performed in various situations, and the fact that Mr. Mason himself well recognizes the proper limits to which a primary battery can be applied, are evidence of the character of the cell. We may add that the Empire Electric Company of this city have undertaken the agency for the same.

MAGNETISM.

BY DR. JOHN HOPKINSON, F.R.S.

(Concluded from p. 271.)

What explanations have been offered of the phenomena of magnetism? That the explanation must be molecular is apparent. Poisson's hypothesis was that each molecule of a magnet contained two magnetic fluids, which were separated from each other under the influence of magnetic force. His theory explained the fact of magnetism induced by proximity to magnets, but beyond this it could not go. It gave no hint that there was a limit to its magnetization of iron—a point of saturation; none of the hysteresis; no hint of any connection between the magnetism of iron and any other property of the substance; no hint why any magnetism disappears at a high temperature. It does, however, give more than a hint that the permeability of iron could not exceed a limit much less than its actual value, and that it should be constant for the material, and independent of the force applied. Poisson gave his theory a beautiful mathematical development, still useful in magnetism and electrostatics.

Weber's theory is a very distinct advance on Poisson's. He supposed that each molecule of iron was a magnet with axes arranged at random in the body; that under the influence of magnetizing force the axes of the little magnets were directed to parallelism in a greater degree as the force was greater. Weber's theory thoroughly explains the limiting value of magnetization, since nothing more can be done than to direct all the molecular axes in the same direction. As modified by Maxwell, or with some similar modification, it gives an account of hysteresis, and of the general form of the ascending curve of magnetization. It is also very convenient for stating some of the facts. For example, what we know regarding the effect of temperature may be expressed by saying that the magnetic moment of the molecule diminishes as the temperature rises; hence that the limiting moment of a magnet will also diminish; but that the facility with which the molecules follow the magnetizing force is also increased, hence the great increase of μ for small forces, and its most instantaneous extinction as the temperature rises. Again, in terms of Weber's theory we can state that rise of temperature enough to render iron non-magnetic will not clear it of residual magnetism. The axes of the molecules are brought to parallelism by the force which is impressed before and during the time that the magnetic property is disappearing; they remain parallel when the force ceases, though being now non-magnetic, their effect is *nil*. When, the temperature falling, they again become magnetic, the effect of their direction of their axes is apparent. But Weber's theory does not touch the root of the matter by connecting the magnetic property with any other property of iron, nor does it give any hint as to why the moment of the molecule disappears so rapidly at a certain temperature.

Ampére's theory may be said to be a development of Weber's; it purports to state in what the magnetism of the molecule consists. Associated with each molecule is a closed electric current in a circuit of no resistance; each such molecule, with its current, constitutes Weber's magnetic molecule, and all it can do they can do. But the great merit of the theory—and a very great one it is—is that it brings magnetism in as a branch of electricity; it explains why a current makes a magnetizable body magnetic. It also gives, as extended by Weber, an explaination of diamagnetism. It, however, gives no hint of connecting the magnetic properties of iron with any other property. Another difficulty is this: When iron ceases to be magnetizable, we must assume that the molecular currents cease. These currents represent energy. We should, therefore, expect that, when iron ceased to be magnetic by rise of temperature, heat would be liberated; the reverse is the fact.

So far as I know, nothing that has ever been proposed even attempts to explain the fundamental anomaly, why do iron, nickel and cobalt possess a property which we have found nowhere else in nature? It may be that at lower temperatures other metals would be magnetic, but of this we have at present no indication. It may be that, as has been found to be the case with the permanent gases, we only require a greater degree of cold to extend the rule to cover the exception. For the present, the magnetic properties of iron, nickel and cobalt stand as exceptional as a breach of that continuity which we are in the habit of regarding as a well-proved law of nature.

After the delivery of this address, **SIR WILLIAM THOMSON** said the president had done well to emphasize the marvellous properties of iron, nickel and cobalt, but he thought these properties were not quite so much isolated as would appear from the address. Faraday showed the continuity between paramagnetic and diamagnetic bodies, and that all substances are susceptible to magnetism when subjected to sufficiently intense magnetizing forces. He had also compared the relative susceptibilities of materials, such as glass, bismuth, wood, etc.; but the absolute determination of their susceptibilities still presents a large field for interesting and valuable research. The fact that the magnetic properties of such substances could be compared was itself of immense importance, whilst Tyndall's observations on the properties of bread, Iceland spar, etc., which can be made, or are naturally, magnetically anisotropic further enhances the interest connected with the subject. As regards the president's remark that Poisson's theory gave no hint of hysteresis, this, he thought, was open to question, for the theory refers to coercive force, and this is hysteresis under another name. Coming to the subject of recalescence, Sir William said this was of immense importance, and one of the wonders duly accentuated by the president. In this connection, he wished to add, that most of the work on latent heat of iron, about the temperature at which the recalescence occurs, had been done by the president himself. The region about the ripple in Fig. 13 requires further investigation, and, if possible, a cycle such as Andrews used in his experiments on evaporation and condensation should be devised. The material exists in two or more different states at the same temperature, and if the effect is reversible, then the iron should cool whilst heat is being applied to it. In conclusion, Sir William suggested that several physical properties of the material should be tested statically whilst it was kept at temperatures little above and little below the critical one, and also during the various states in which the material exists at the same temperature.

PROFESSOR EWING, in commenting on the enormous amount of hysteresis exhibited by the alloy of nickel and iron, Fig. 11, said he had looked for hysteresis in similar alloys and found none; now he saw why he found none, for his experiments were made between ordinary atmospheric temperatures and 212°F., whilst Dr. Hopkinson, by increasing the range of temperature, had passed the critical points and shown the hysteresis to be very great. In his own (Professor Ewing's) experiments on iron, he found that by tapping a rod whilst subjected to magnetizing force, a permeability of 20,000 could be obtained.

CORRESPONDENCE

NEW YORK AND VICINITY.

The Lenox Lyceum Electrical Exhibition.—An Electrical Eiffel Tower.—Mr. Kearney on Gas Mains and Steam Pipes.—The Apparatus for Executing Kemmler.—Subway Board Meeting.

THE Electrical Exhibition at the Lenox Lyceum, continues to be visited by a large number of people, and it seems likely that the attendance will be heavy during May, on the 15th of which it closes. The importance of the Exhibition is being more and more recognised, and one feature has been the number of celebrities visiting it. Dr. Wangemann, the able and courteous director of the phonograph department, has frequent opportunities of entertaining leading New Yorkers in his fascinating laboratory, not only with pithy little lectures on sound and music, but with the reproduction of some of the voices of great Europeans. An invitation to the Doctor's "den" is one of the honors of the Exhibition.

It is said that Mr. Henry Villard has promised, on behalf of the Edison Company, to have the electrical exhibit brought to the Minneapolis Exposition, which opens in August. It is also said that Mr. Eiffel has made a proposition to the World's Fair Directors to erect a similar structure in Chicago, and provide the entire capital needed for its construction should the directors approve of his proposition. It will be the joint erection of Mr. Eiffel and Thomas A. Edison, and will surpass in altitude the original structure by at least 500 feet. Mr. Edison, it is said, contemplates placing a million multicolored electric incandescent lights upon the structure, and making it one of the most marvelous and beautiful spectacles ever witnessed in the world. If this be so it is certain that Mr. Luther Stieringer, the designer of the Lenox "Tower of Light" will be very much in demand, to carry out the scheme.

At the investigation of the State Senate Committee on General Laws, which proposes to establish a State electrical board, Mr. Henry S. Kearney, chief engineer of the Board of Electrical Control, was called upon to testify on the gas and subway question in New York city. He said that the city is gridironed with gas mains ranging from four to 20 inches in diameter. In some streets, and on Sixth avenue especially, there are four sets of gas mains on each side of the street. Mr. Kearney says that gas is continually escaping from these mains from leaking joints, and he believed that in 95 out of 100 holes dug in the streets between 14th and 23d streets and 3d and 9th avenues, escaping gas would be found before the main was reached. In laying the conduits he found many gas mains so corroded that they broke in handling, and also found old service "cut-offs" made by simply hammering the ends of the pipes together. Mr. Kearney says the steam-heating pipes also gave them much trouble. Ten feet below the surface of Broadway, from Howard street to Exchange place, the temperature of the earth was above 100° F., caused by escaping steam from defective joints. This heat, in combination with acids in the soil, destroys the insulation on underground wires. The Telephone Company has been forced to lay a new cable especially prepared to resist these effects. The brass pneumatic tubes of the Western Union Telegraph Co., laid three years ago, are also badly corroded from these causes. Mr. Kearney thought these evils could be remedied, and was in favor of a supervisory board to control "the gas and steam companies." Mr. James W. Smith, President of the Consolidated Gas Co., appeared for the defense. He said that the gas mains were laid under inspection, and were as tight as it was possible to make them. They were injured by the frequent and careless tearing up of the streets. He said the quantity of escaping gas was over-estimated, instead of eight or ten per cent., as stated by Mr. Kearney, he did not think it was over one per cent. Mr. Smith claimed that the subways had been laid with absolute recklessness, and without regard for the rights of other underground work. In some places they had built solid brick and cement structures right on top of gas mains.

The Board of Electrical Control held a meeting in the Mayor's office last week and took a report presented by the expert of the Board, Dr. Wheeler, regarding the question, which was referred to him, of the effect of heat on the underground wires in Broadway. Dr. Wheeler reported that it did not seem practicable to make a cable the insulation of which would not be lowered by the increased temperature occasioned by the proximity to the subway of steam-heating pipes, inasmuch as all the best insulating substances vary in resistance with rising temperature. The matter of devising a method for reducing the heat in the subways was one which, Mr. Wheeler said, had been under consideration for a good while, and it did not seem to him that objectionable heating would be overcome for some time. Mayor Grant interrupted the electrical expert at this stage to say that it was proposed to remove and replace all steam-heating pipes in Broadway when the repaving is to be begun, and this, he said, would be within a few months. Dr. Wheeler went on to say that the question was consequently limited to the matter of safety without regard to the effect of heat on insulation considered from any other point of view. He read reports that had been made to him by other electrical experts, some of whom, it appeared, had submitted their opinions, not to Dr. Wheeler, but to the United States Illuminating Company. As soon as this fact came out Mayor Grant rudely declined to hear further, and roughly directed Dr. Wheeler to file a new report based on his own knowledge, and such other facts as he himself could acquire without the aid of any electric lighting company.

The career of William Kemmler is gradually approaching an end. He fully realizes his position, and intends to meet his fate unflinchingly. According to an Associated Press dispatch from Auburn, the arrangements for his execution are nearly completed. The death chamber is about 17 feet wide by 25 feet long, and is dimly lighted by two small iron-grated windows about four feet above the floor, from which a view of the main entrance of the prison can be obtained. Between the windows on the east wall is a long board about 10 feet in length and 3½ or 4 feet high. On this board are arranged appliances for testing, measuring, and governing the death-dealing current. At the left is a push button, which communicates with the dynamo room, and is used for signaling. Next on the right is a Cardew voltmeter, a box containing a coil, and surmounted by a gauge which registers the E. M. F. in volts. Another box, on the right contains a reducing coil to reduce the voltage before it enters the voltmeter or the lamp box on the right.

Between the reducer and the voltmeter is a small switch to turn the current off and on the meter. The lamp box contains twenty-four sixteen-candle-power incandescent lamps, and shows when the current is on and running steadily. Then come two switches, one for short circuiting the current, the other the fatal switch which carries the current to the wires connecting with the body of the condemned man. Two wires at the top connect with a dynamo 1,000 feet away in the north wing of the prison. One of the wires at the bottom will be connected with the metal cap to be worn on the head, and the other will be adjusted to the base of Kemmler's spine.

At present these two wires remain dangling from the ceiling. They will be attached to a board three feet square fastened to the ceiling, which is already in position, and which is directly over the spot where the chair is to be placed.

NEW YORK, April 28, 1890.

BOSTON.

Boston Harbor Protection.—Electric Light Warfare.—Electric Legislation.—Committee Reports.—Municipal Control of Electric Light Plants.—Consolidation of Gas and Electric Interests.—Inspection of Electric Lights.—Boston Electric Club.—First Ladies' Reception a Grand Success.—Next Meeting of the Club.—Work in the Common Council.—Speed of Electric Cars.

THE War Department are preparing plans for a system of casemates, or underground stations, for the operation of submarine torpedoes in Boston harbor should they ever be required. These casemates will contain complete electric apparatus for the exploding of torpedoes, though the torpedoes themselves will not be placed unless it is found necessary to protect the harbor from some foreign invasion. The placing of the torpedoes is a work of but a few hours, and with the wires run into casemates the operators are secure from danger.

The gas commissioners Wednesday morning heard the petition of the Boston Electric Light Co. that the attorney-general be requested to proceed against the Suburban Light and Power Co. E. W. Burdett, counsel for the Boston company, claimed that the Suburban company was maintaining a plant and erecting wires without a license from anybody. Mr. Burrage, for the Suburban company called the attention of the commissioners to the law under which the action was asked for, which makes it necessary for the board to satisfy itself by investigation that the law is being violated. The commissioners reserved their decision.

The Legislature has had various electric interests under consideration, and several committee reports have been made this week. The committee on manufactures made a report relative to their investigations at Alexandria, Richmond and Philadelphia as to the manufacture and sale of gas and electric lights by municipalities. The committee does not consider it advisible to recommend the adoption of municipal control of gas or electric light works in Massachusetts cities and towns. The same committee reported a bill to authorize the consolidation of gas and electric light companies, and also a bill providing for the inspection of electric lights and meters to ascertain the candle power and energy consumed by electric lights, and to test electric meters.

The rooms of the Boston Electric Club were the scene of one of the most pleasant gatherings which have ever taken place under the auspices of the club. For months past there have been many suggestions from members that there should be a ladies' night, and the house and entertainment committee have reason to be congratulated upon the immense success of their effort to comply with the general wishes of the members. The rooms were handsomely decorated with flowers, electric fixtures, numerous pictures representing various electric interests; and the splendid array of birds, kindly loaned by Mr. A. B. Griggs, a popular member of the club, were tastefully suspended from various points, giving the rooms a decidedly cosy appearance. About one hundred and fifty ladies and gentlemen were present. Entertainment had been provided for them in the shape of a unique exhibition of the phonograph which elicited much applause with its marvelous reciting abilities. Two handsome speaking dolls, kindly loaned for the occasion by the Edison Phonograph Toy Doll Co., also attracted a great deal of attention, and were a source of endless amusement to the ladies and their escorts. These dolls are made to recite some well-known nursery rhyme upon the turning of a crank, and when well manipulated speak in remarkably distinct tones, considering the source of speech, and their moderate price. A suitable banquet was provided for the refreshment of the members and their guests, under the able management of the club steward, Mr. William Allen, the menu being neatly printed on the rice paper napkins, which were eagerly seized upon as an interesting memento of the first night of the kind in the annals of the club. Each gentleman was presented with a boutonniere on entering, while the ladies were also the recipients of a neat corsage bouquet. Most of the arrangements were made under the supervision of Mr. Alex. P. Wright, the popular secretary of the house and entertainment committee, who deserves great credit for the perfect arrangements and complete success of the evening. It is hoped that many more such entertainments will be provided in future as everyone was entirely pleased.

The next important meeting of the club will be on Monday, the 28th inst., at the club rooms, when Mr. George W. Mansfield will read a paper on "Single and Double Trolleys for Electric Railways." Mr. Mansfield is well known as an earnest worker in the practical field of electric railway work, and there will undoubtedly be a large attendance.

Through some error of manuscript it was stated last week that the New England Wiring and Construction Co. had secured the contract for the *Telephone* Exchange building. Such is not the case. What was intended was the Stock Exchange building on State street, now in course of construction, which the New England company will commence to wire as soon as ready. The contract for the new Telephone building on Milk street, has not yet been given out, and indeed it is not yet decided whether electric lights will be used.

At a meeting of the board of the Common Council, an order providing for a visit to New York city and Philadelphia in order that electric lighting plants there may be examined, with a view of introducing one into the Boston City Hall, was presented, discussed at length, and finally passed, and the council refused to reconsider it; also the council concurred with the aldermen on the following order:

"That the joint special committee on electric light plant for City Hall be authorized to report estimates for furnishing and establishing an electric light plant in the basement of City Hall, for lighting City Hall, the courthouse in Court square and the registry of deeds building."

As a result of the recent public hearing regarding the rate of speed of electric cars, the Board of Aldermen as a committee of the whole has decided to report to the board next Monday in favor of increasing the rate of speed from Westchester Park to Pleasant Street, on Shawmut Avenue, from seven miles an hour to ten miles an hour between Pleasant Street and other points in the city proper. From Westchester Park out through Dorchester and Roxbury the speed will be twelve miles an hour, and this order will apply to the Brighton section.

Mr. F. M. Gilley, of Chelsea, read an exceedingly interesting paper before the Society of Arts in Boston this week, on "Central Electric Lighting Stations in London." The lecture was profusely illustrated with stereopticon views.

BOSTON, April 26, 1890.

PHILADELPHIA.

The Telephone Service.—The New Franklin Institute Building.

AT a special meeting of the Maritime Exchange a few days ago it took up the question of Philadelphia's telephone service, and after a short discussion referred the matter to the Room Committee of the Exchange. Secretary Edward R. Sharswood said that the Exchange had been somewhat misrepresented. It is ready to join heartily in an investigation of the service.

Audubon, which is a pretty New Jersey town just out of Camden, has push and energy about it. Arrangements are being made for an extensive electric light plant. It will be completed in a short time, and then Audubon will be one of the few New Jersey towns lighted by electricity.

The arrangements for the erection of a new building for the Franklin Institute are at length beginning to take definite shape, and it is expected that a site will be secured early next month. The construction of this building is an absolute necessity, as the Institute has one of the most valuable scientific libraries in the country, which, in its present quarters, is in danger of being destroyed by fire at any moment. The original committee of seven on the new building was last autumn enlarged to a committee of 100, but its work was delayed by the absence in Europe of Joseph M. Wilson, the architect. Since his return, however, the sub-committee on finance has resolved to raise $100,000 by subscription, and it has already obtained $40,000 of that amount, principally from the members of the committee of 100. It is estimated that from $300,000 to $400,000 will be needed for the purchase of the site and the erection of a handsome fire-proof building.

A charter was issued at Harrisburg yesterday to the Michales Electric Mining Machine Co., of Pittsburgh, with a capital of $500,000.

Electric lights will soon gleam from two 350 feet towers at Cramer Hill, a suburb of Camden, N. J.

PHILADELPHIA, April 25, 1890.

ST. LOUIS.

Bills in the Municipal Assembly.—Electric Railway Work.—Extension of Electric Lighting.

THE Municipal Assembly resumed summer sessions last Tuesday, at which the following electrical bills were introduced: The Bell Telephone Co., of Missouri, ask for the privilege of laying their own subways. The Postal Telegraph and Cable Co. ask for the privilege of laying a subway from their cable landing at the foot of Biddle street to their main office on Olive street. The North and South Rapid Transit Railroad ask for the privilege of constructing a double track street road from Cherokee street in the south part of town, across Eighteenth street bridge to Calvary cemetery in the extreme north end of the city, with two branch lines down town. Electric power, cable, gas motor or horses may be used as motive power.

The Cross Town Railway proposes a similar route, beginning at the cornor of Park and Mississippi avenues in the south end of town across the Eighteenth street bridge to North Market street. Any kind of motive power is permitted.

The bill of the St. Louis Central and Western Railway Co. has been signed by the mayor. A permanent organization of this company was effected this week, at which Jos. C. George was elected president, Geo. L. Peabody, vice-president, and H. E. Warner, secretary and treasurer. Preparations for the electric extension to Forest Park will be taken up immediately. It is also given out that the new company are considering the advisability of equipping the entire line with electric power and abandoning their cables. The old road (the Cable and Western) having a number of short curves has always been very expensive to operate.

The Electric Lighting Committee of the Board of Public Improvements, have recommended that an ordinance be prepared providing for the lighting with electric lights of that part of the city south of Keokuk street. The territory south of Keokuk street is now lighted with gas by the Carondelet Gas Co. Their contract with the city expires June 1. The new contract when authorized will fall to the Municipal Electric Light and Power Co. for the arc lights, and to the Missouri Electric Light and Power Co. for incandescent lights.

The St. Louis Railroad Co.—the Broadway line—will hold a meeting May 5, for the purpose of voting upon a proposition to increase the capital stock from $1,000,000 to $2,500.000 and the bonded indebtedness to $2,000,000. The object of this increase is to equip the main line with cable and the Seventh street section with electric power.

L. M. Chipley, financial agent, has brought to notice a scheme for a street car loop line, in the centre of the city to be used by all street car lines. The route proposed covers Fourth and Sixth streets and Clark and Franklin avenues. The Union Depot Line who already have a loop line covering almost the same territory, do not favor the scheme. All other roads are favorable to the scheme. In order to accommodate all the roads, both cable and overhead electric supply will be used.

ST. LOUIS, April 25, 1890.

CHICAGO.

The Morgan Electric Coal Cutter.—The Fort Wayne Central Station.—Foree Bain's Work.—Applications of the Pumpelly Storage Battery.

A NEW and ingenious coal cutter has just been devised by Mr. Morgan, of this city, who has given the problem much thought and attention. The operation of the machine is effected by a combination of the solenoid and horse shoe magnet principles and not by means of a rotary electric motor as in the machines designed heretofore for this class of work. It comprises the electromagnetic actuating apparatus by means of which a powerful spring is compressed, the expansion of the latter operating an ordinary pick such as is employed in the Harrison and other air machines. The arrangement is such that the solenoidal magnet exerts a very powerful pull upon its core, thereby compressing the spring; a switch is then automatically actuated which sends the current in opposite directions through the two halves of the solenoid neutralizing its magnetic actions, whereupon the spring comes into action and causes the pick to strike a powerful blow. The machine is calculated to absorb about 3 h. p., and is claimed to be highly efficient in operation. Mr. Morgan is now engaged in thoroughly testing his invention.

The Fort Wayne Electric Co. of this city, who are supplying current from their station to some 4,000 incandescent lamps by the well-known Slattery induction system are contemplating an increase of plant to double its present capacity, and will put the work in hand right away. Ever since the start, they have been continually pressed for more current and have been putting in new machines to fill the demand right along.

Foree Bain has just installed one of his new type of motors in the Chicago Paper Co.'s building. The motor is of 7 h. p. capacity, and is used for running the elevator and cutting machines. It does its work with the greatest ease and is giving the greatest satisfaction. The gas engine which formerly did this work is like Othello with "its occupation gone."

The Pumpelly Storage Battery and Electric Motor Co. have just closed a contract with Mr. C. M. Woodbury, of the Middlesboro Town Co., Middlesboro, Ky., to equip three cars with their storage batteries. These cars were built by the John Stephenson Co. of New York, and are now being fitted out with motors, etc., at Detroit. They are to be fully equipped and in operation by May 20. The storage battery is gradually gaining ground in electric traction work and the operation of these cars will be watched with much interest. Among other applications of the storage battery, this company has installed a set of their cells in the new apartment house built by Dr. Johnson, on 37th street and Lake avenue. The electric light is furnished to the occupant from an isolated plant located in the building, the dynamo running until 9 P. M., after which hour the light required during the night is furnished by the storage batteries. This, it is stated, is the first plant of the kind installed in an apartment house in the west, for the benefit of the occupants, and will undoubtedly be followed by numerous similar applications, as the advantages obtained by having a constant and ever present supply of light without the attendant annoyance of continual moving machinery are very apparent. This is one of the cases in which the utility of the storage battery is very clearly demonstrated. A special switch has been designed for this company by Dr. Paul Schoop, for use with cells when charged by means of a dynamo operated by wind power. This switch is perfectly automatic in its action and both makes and breaks contact and takes care of the cells and dynamo, rendering them independent of any variations in power or other troubles liable to arise and completely solving the difficulties which have been hitherto encountered in such plants. It is being used for this purpose at Batavia, and has given the greatest satisfaction.

CHICAGO, April 25, 1890.

PITTSBURGH.

An Electric Railway Strike.—New Electric Railway "Deals."—Westinghouse Statistics.

SIX of the firemen employed at the power house of the Pleasant Valley Electric Street car line in this city, went on a strike last Sunday morning for an increase in their wages. The men have been getting $1.63 per day, but a week ago they asked for $2.00 per day, which the company, however, refused, and the result was, that the men left their jobs last Sunday. The company has since succeeded in getting new men in the strikers' places and the operation of the street cars was but very slightly interfered with.

The street railway syndicate, which is composed of H. Sellers McKee, of Pittsburgh, Murray Verner, of Buffalo, and E. H. Clark, of Drexel, Morgan & Co.'s Philadelphia banking house, is reported to have purchased another street railway system. This time these men are said to have bought the entire street car lines of Louisville, Ky., paying $1,200,000 for them. The street railways of Louisville are antique in the extreme, and with the exception of those on the downtown streets, are operated on the switch system. The suburban branches do not extend as far as they could with profit. The Broadway line and the Sixth avenue line have been great money makers, and the prosperity of the latter dates back to the establishment of the exposition at its terminus. Several years since the lines all over the city were consolidated and the equipment was somewhat improved, but rapid transit was apparently unthought of until Messrs. McKee and Verner took in the situation and its possibilities. Negotiations were commenced two weeks ago and the transfer was made last week. The company in Louisville will be reorganized and a reconstruction of the entire system will be inaugurated. Electricity will be the motive power on all the lines. Which system, however is to be used has not been decided yet. Bonds will be floated to meet the cost of equipping the road. This is a method, which the syndicate has successfully tried in Buffalo, Rochester, Syracuse and Newark, the other cities in which this syndicate has control of the street car systems. In Pittsburgh, $1,500,000 worth of their bonds are now on the market. The syndicate is still looking for other cities. Columbus, O. was offered for sale, but the Elkins-Widener syndicate got in first and now owns the system. Indianapolis was also considered, but since Mr. Harrison went to Washington to live, the bottom dropped out of things in the "Hoosier capital," and everybody walks to save money.

Mr. Murray Verner, who has heretofore acted as negotiator and appraiser, became a member of the syndicate in the Louisville deal. Pittsburgh at this rate will soon have all the available systems of the country in the hands of her citizens. An enormous "deal" is said to be now pending, which will be as big as all the rest of the deals put together.

The motor department of the Westinghouse Electric Co. where the motors and other appliances of the Westinghouse electric street car system are manufactured, is now in full operation. The company received the other day a contract from the Lansing Street Railway Co. for a complete equipment of their line with the Westinghouse motor.

The Washington Carbon Co., of Washington, Pa., is now erecting an addition to its works which will greatly increase the capacity of the concern. The probability is that the largest portion of the plant will be under roof by next June, giving the company an opportunity of manufacturing every day from 50,000 to 60,000 carbon points.

Work has been commenced on the Wilkinsburg Electric line. The tracks are being laid now and the company expects to have its cars running by next September.

A comparative statement of the sales of the Westinghouse Electric Co. for the first quarter of 1889 and 1890 shows these figures: 1889, $621,336.92; 1890, $1.111,970.41, or an increase of 80 per cent. If this is kept up, the present year's business will aggregate about $7,500,000, as against $4,500,000 in 1889.

PITTSBURGH, April 25, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

LOSS BY HYSTERESIS.

[124]—In his letter (121) appearing in your issue of April 9, page 221, Mr. N. Tesla in discussing the losses due to hysteresis in transformers takes the ground that such losses outside of the generation of electrical currents, or independent thereof, are "difficult to reconcile with our present notions on the constitution of matter generally." Further on he says: "We cannot imagine that an appreciable amount of energy should be *wasted* by the elastically connected molecules swinging back and forth from their original position," etc. While I agree with Mr. Tesla that the actual loss referred to may be due to molecular currents, yet we have no proof of such fact. Again Mr. Tesla seems to forget that *loss, waste*, and such terms, are more scientifically rendered, by the words "*conversion into heat*," and that in nature nothing is wasted or lost, but merely converted.

Now we may consistently amend his quoted statement as follows, and see how it reads: "We cannot imagine that an appreciable amount of energy should be converted into heat by the elastically connected molecules swinging back and forth from their original positions," etc

Heat action is that swinging back and forth referred to, namely, "molecular vibration," and if we find that such swinging takes place we must have heat as a result. When the molecules can polarize or turn without being given a swinging movement or vibration, no conversion into heat takes place. The difference then between very soft iron and hard steel so far as magnetic waste goes, is, apparently, that in the soft iron there is less disturbance of position of the molecules during magnetization and reversal then in steel, assuming the degree of magnetization or polarization to be equal in each. The *waste* or conversion due to electrical resistance is of the same nature. Whenever the ether strain can be transmitted from molecule to molecule of the conductor without much disturbance of their positions or without causing a swinging out of position back and forth, the conductivity is great and the reverse is true with bad conductors.

In like manner, bending a bar of tempered steel back and forth within limits is mechanically efficient because very little conversion of motion into heat takes place, and this is a result of the relative positions of the molecules being preserved; while, bending a bar of inelastic metal, as a copper rod of moderate hardness, produces heat by disturbance and swinging of molecules. Such bending is inefficient.

There is then to my mind no more difficulty in understanding that a conversion into heat may be produced magnetically than electrically, or mechanically. Indeed, if, as seems probable, these actions are but variations of ether strain phenomena they are reducible to a single effect, and represent the molecular disturbances produced by transmission of ether strains. Cohesion, gravitation and forces acting between molecules, must of course be recognized as results of ether strains.

Molecules themselves, or matter itself, may be resolvable into ether movements or vortices, and we may be able to put "energy indestructible" in place of "matter indestructible" and mean as much. We need to forget the universe as made up of pieces, entities or particles, put together and allowed to interact and react, and learn to regard it as a consistent whole from which nothing can be taken without disturbing the balance or equilibrium of what remains. It is in my view more legitimate to attribute the heating effects of Foucault currents and other currents to a general molecular friction or hysteresis of conduction, if we may use such a term, than to assume the production of molecular currents in the heating or conversion of magnetic hysteresis. We have no present need of currents in accounting for heat conversion of mechanical friction and molecular friction of inelastic bodies when bent or distorted by mechanical force. Neither can we deny that theoretically such conversion into heat may be accompanied by molecular electric currents similar to eddy currents or Foucault currents, but infinitely more restricted as to length of circuit. On these points and others of equal interest we may speculate, but are in need of more facts to confirm our speculations.

ELIHU THOMSON.

LYNN, MASS.

WORDS OF GREETING.

This important American electrical journal which has appeared monthly since 1881, will hereafter appear weekly under the direction of T. Commerford Martin and Joseph Wetzler, who have left *The Electrical World* in order to devote themselves exclusively to THE ELECTRICAL ENGINEER. In view of the development of *The Electrical World* under the direction of Messrs. Martin and Wetzler, we can only express to our contemporary our regrets at this sudden change, and, on the other hand, congratulate THE ELECTRICAL ENGINEER on its new organization.—*L'Electricien*, Paris.

The appearance, on April 7, of the first weekly issue of THE ELECTRICAL ENGINEER, is noteworthy for several reasons. The journal started as a monthly, and, up to the date of the change, just ninety-nine numbers had been published under the editorial management of Franklin L. Pope and George M. Phelps. Under the new régime, Mr. Phelps remains as president of the corporation; T. Commerford Martin and Joseph Wetzler, formerly of the *Electrical World*, occupy the editorial chair; Frank R. Colvin is treasurer and business manager; and the management of the branch offices in Boston and Chicago will be in the hands of A. C. Shaw and W. F. Collins respectively. It is safe to say that a finer working team of journalists could not readily be got together. We extend to our valued contemporary our best wishes that all its hopes may be realized, and that its future may be abundantly bright and profitable.—*Practical Electricity.*

The issue of THE ELECTRICAL ENGINEER for April 2. is the first on a change from monthly to weekly. The periodical has been in existence for over eight years, and has become one of the most valuable electrical periodicals in the country. Hereafter it will be issued weekly. This periodical treats everything new in electrical science in a sufficiently technical and careful way to make it of value alike to the student and the practical man.—*Berkshire County Eagle.*

THE WHELESS ELECTRIC RAILWAY SYSTEM.

For several months past experiments have been carried on by Mr. Malone Wheless, at Washington, D. C., on a new system of operating electric cars, and as a result a trial of the system was made last week in the presence of a large number of prominent gentlemen. The test took place in a large open field near the power house of the Eckington electric road, and on which a rough track had been laid, which includes grades of 10 and 12 per cent.

The principal feature of Mr. Wheless' system consists in a novel method of conducting the current to the motor on the cars. Between the rails a shallow insulated conduit is built, through a narrow slot in which a wheel makes contact with the power wire.

At intervals of 90 or 100 feet the power wire is broken and connected with traps, into which a buried wire leads that carries the current from the power house. The novelty of the system consists in having only that section of the power wire vitalized or charged on which the car happens to be at the time. This is done by a small storage battery on the car closing the connection between the conducting wire and the power wire in the conduit, the circuit being made and broken in the traps by a system of electro-magnets. By this means no part of the power wire is charged except the one section of 90 feet with which the trolley is in contact. This prevents the leaking of current and reduces the line resistance.

The tests were very successful, the heavy grades and curves being easily surmounted with the car heavily loaded.

Mr Wheless claims that the initial cost of construction will not exceed $5,000 per mile and that the cost of maintenance is very small.

LIST OF SPRAGUE ELECTRIC RAILWAYS.

We are indebted to the Sprague Electric Railway and Motor Co. for the following list of their roads:—

Railways.	No. of Motor Cars.
Akron, O., Electric.	24
Asheville, N. C., Electric	8
Atlantic City, N. J., Electric	17
Augusta, Ga., Street	16
Baltimore, Md., North Ave., Electric	1
Bay Ridge, Md., Electric	2
Berlin, Germany, Exper. Elekt. Eisenb der Allgem. Elek. Ges	3
Binghamton, N. Y., Washington Street Asylum and Park	4
Binghamton, N. Y., Street	24
Brockton, Mass., East Side, Street	4
Brooklyn & Jamaica, N. Y., Street	4
Buffalo, N, Y., Street	4
Canton, O., Street	10
Chattanooga, Tenn., Electric	16
Chicago, Ill., Cicero & Proviso	12
Cincinnati, O., Incline	20
Cleveland, O., Broadway and Newburgh, Street	24
Cleveland, O., East Cleveland, Street	75
Colorado Springs, Col., El Paso Rapid Transit Co	18
Council Bluffs, Ia., Omaha & Council Bluffs	2
Dallas, Tex., Rapid Transit	3
Davenport Ia., Central	6
Davenport, Ia., Electric	4
Dayton, O., and Soldier's Home	2
Denver, Col., So. Denver, Cable	2
Denver, Col., University Park	3
Denver, Col., Colfax Ave., Electric	4
Des Moines, Ia., Electric	2
Detroit, Mich., Rouge River and Dearborn	5
Dubuque, Ia., Elec. Ry. Lt. & Power Co	12
Dubuque, Ia., Key City Electric	2
Eau Claire, Wis., Eau Claire Street	6
Elgin, Ill., Elgin City	9
Erie, Pa., Electric Motor Co.	21
Florence, Italy, Firenzi and Fiesole	12
Fort Worth, Tex., Arlington Heights.	3
East Harrisburgh, Pa., Pass.	11
Hartford, Conn. and Weathersfield	4
Kearney, Neb., Electric	2
Lafayette, Ind, Electric	9
Laredo, Tex., Imp't Co	7
Lexington, Ky., Pass. & Belt	10
Long Island City & Newton Ry., N. Y	2
Los Angeles, Cal., Electric Rapid Transit	10
Marlboro, Mass., Street	6
Milwaukee, Wis., West Side, Street	19
Minneapolis, Minn., Street	100
Moline, Ill., Electric	2
Nashville, Tenn., South Nashville, Street	10
Nashville, Tenn., Nashville & Edgefield, Street	10
Newark, O. & Granville, St.	1
Omaha, Neb, Street	37
Paducah, Ky., Street	9
Piqua, O., Electric	4
Pittsburgh, Pa., Federal St. & Pleasant Valley Pass.	45
Plattsmouth, Neb., Electric.	2
Portland, Ore., Metropolitan Street	13
Portland, Or., Multnomah Street.	10
Portland, Or., Wilamette Bridge	6
Quincy, Ill., Horse Ry. & Carrying Co	8
East Reading, Pa., Pass	6
Reading, Pa., Neversink Mt. Ry. Co	4
Richmond, Va., Union Pass.	42
Salem, Mass., Naumkeag St.	6
Salem-Winston, N. C., Elec.	7
Salem, Ore., Capital City	2
Salt Lake City	35
Scranton, Pa., People's St.	20
Sedalia, Mo., Street	4
Sherman, Tex., College Park Electric Belt Line	5
Sioux City, Ia., Street	20
Sioux Falls, So. Dak., So. Dakota Rapid Transit & Ry. Co	3
Sterling, Ills., Union Elec.	7
Steubenville, O., Elec. St.	8
Stillwater, Minn., Street	4
St. Joseph, Mo., People's St.	18
St. Paul, Minn., Street	80
St. Joseph, Mo., Union Pass.	20
St. Joseph, Mo., Wyatt Park Ry. Extension	18
St. Louis, Mo., Lindell	80
Tacoma. Wash., Street	56
Tokio, Japan, Exhibition	2
Troy, N. Y., & Lansingburg.	24
Utica, N. Y., & Mohawk	5
West Bay City, Mich., St.	12
Wilkesbarre, Pa., & Suburban	6
Wilkesbarre, Pa., & West Side	3
Wilmington City, Del., Elec.	10
Youngstown, O., Elec. St.	6

Making a total of 1,228 motor cars.

REPORTS OF COMPANIES.

ANNUAL REPORT OF THOMSON-HOUSTON ELECTRIC CO.

THE following is the report of the Company dated February 1, 1890, just issued:

CAPITAL STOCK AUTHORIZED BY CHARTER:

Preferred Stock	$5,000,000.00
Common Stock	10,000,000.00
Total	$15,000,000.00

CAPITAL STOCK PAID IN FEBRUARY 1, 1890:

Preferred Stock	$1,000,000.00
Common Stock	4,500,000.00
	$5,500,000.00
Surplus	$1,685,415.92
Total Paid-up Capital and Surplus	$7,185,415.92

Sales of preferred stock since February 1, 1890, for which cash has been paid in........ $1,650,225

Statement of Profits and Surplus Account.

	Added to Surplus from Profits.	Total Surplus.
January 1, 1883	$17,237.85	
" 1, 1884	93,696.74	$110,934.59
" 1, 1885	96,187.10	207,111.69
" 1, 1886	106,687.50	313,809.19
" 1, 1887	123,006.05	426,815.24
February 1, 1888	313,596.67	750,411.91
" 1, 1889	660,828.82	1,411,240.73
" 1, 1890	1,309,175.19	1,685,415.92

The surplus account February 1, 1889, was $1,411,240.73; from which there has been divided among the shareholders $1,000,000 as stock dividend, and a cash dividend of $35,000 on preferred stock. There has been added, as above, $1,309,175.19, making the present surplus $1,685,415.92. Before carrying the above amount to surplus there had been delivered to trustees "series D." securities and claims amounting at face value to $2,410,289.13.

The amount of annual business has increased from $300,000 in 1883, to $8,000,000 in 1889.

We have about 100 lines of electric railways under contract and in operation aggregating over 1,000 cars, as a result of less than two years' operations of this department.

Local companies using the Thomson-Houston arc and incandescent lighting system in the United States.

	No. of Companies.	No. of Arc Lamps.
January 1, 1883	5	365
" 1, 1884	31	2,478
" 1, 1885	59	5,867
" 1, 1886	100	13,227
" 1, 1887	171	21,849
" 1, 1888	303	36,936
" 1, 1889	419	51,621
" 1, 1890	587	68,203

There are companies operating this system in England, Italy, Ireland, Sweden, South and Central America, Finland, France, Germany, Spain, Russia, Japan, West Indies, Australia; in fact in nearly every civilized country in the world not included in above.

We have, in addition to the above, about 400 incandescent companies operating between 300,000 to 400,000 lights. We have also several hundred isolated plants in factories, hotels, etc., which number is rapidly increasing.

A full and detailed statement of all the operations of the company was presented to the stockholders at the annual meeting, held in Middletown, Conn., on Monday, April 14, and is on file at the office of the company. Full details of the assets and liabilities of the company are omitted from this exhibit for the reason that they embrace certain stocks of manufacturing and construction companies, and other valuable properties, which the directors believe they have been fortunate in acquiring, and which for obvious reasons, it is not considered wise to disclose in detail at the present time. The assets have been taken upon the usual conservative basis, a discount having been made of 60 per cent. from stocks held in local lighting and railway companies, and 30 per cent. from the first mortgage bonds of such companies. Large deductions have also been made from all other assets, and your directors believe that if the assets were inventoried as is ordinarily done by similar corporations the estimate of the value of your property would be *very largely* increased in amount.

The indebtedness of the company, which is less in proportion to the volume of business than in any previous year, has been reduced since the statement was made by the sale of a little more than a million and a half dollars of additional preferred stock.

The current business of the company is fully 100 per cent greater than a year ago with a corresponding increase in profits. Your directors have every reason to congratulate the stockholders of the company upon the present condition and future prospects of the business of the corporation.

THE NORTHWEST THOMSON-HOUSTON ELECTRIC COMPANY.

The Northwest Thomson-Houston Electric Company manages the business of the Thomson-Houston company of Boston in Minnesota, Wisconsin, Dakota, Montana, Idaho, Wyoming, Oregon, and Washington. It has a capital stock of $500,000, and handles Thomson-Houston electric supplies. From April 1, 1889, to April 7, 1890, the company sold about $1,000,000 worth of apparatus, and has in operation several central stations for city lighting, 49 isolated lighting plants and 18 electric railroads in operation or under construction. The company paid 10 per cent. in dividends during the past year, including the payment of April 7, 1890, and had a surplus April 1, after providing for the dividend, of $203,287 in bills and accounts receivable, securities, contracts, etc., including a nominal amount of cash. The balance sheet of April 1, 1890:

ASSETS.

Franchise and contract	$110,000
Stocks and bonds	164,500
Bills and accounts receivable	568,785
Real estate	500
Plants under construction	54,724
Railways under construction	43,708
Cash	13,603
Miscellaneous	3,415
Total	$1,078,141

LIABILITIES.

Capital stock	$500,000
Bills and accounts payable	374,853
Surplus	203,287
Total	$1,078,141

LITERATURE.

Electric Transmission of Energy. By Gisbert Kapp, C. E. New York: *D. Van Nostrand & Co.*, 1890. 348 pp. 126 illustrations. (Second edition, enlarged). Price, $3.

THE appearance of this new edition of Mr. Kapp's valuable treatise will be hailed with pleasure by all who are interested in the practical and theoretical questions involved in the generation, transformation, subdivision and distribution of current for motive power purposes. It may be said that Mr. Kapp has taken advantage this time of the elasticity of the title of his book, and has gone more fully into a treatment of the dynamo; but this is not a loss to the reader. On the contrary it is a gain, especially as Mr. Kapp has added his method for the predetermination of the characteristics of dynamos. The only regret is that he did not go even further and include some discussion of the alternating current for power transmission. That branch of the subject may still be new, but it is not the less "practical," besides being intensely interesting to a large number of intelligent workers and students. Moreover, there are, to-day, in America at least, alternating current motors actually at work.

Where there is so much that it is good, it seems hypercritical to point out omissions. Yet it is to be regretted that the book does not embrace more details with regard to electric railway operation. One looks in vain for a comprehensive or even cursory review, for example, of methods of overhead wire operation, although, as is well known, a tremendous amount of work and skill have been bestowed on that department of construction. The underrunning trolley wheel has been the subject of more rapid change and perfection than almost any other electrical device during the past two years, but the various innovations and modifications are all passed over in absolute silence. There would, moreover, be much of theoretical as well as practical interest in a treatment of such matters as single *versus* double trolleys; the use of the earth for the return circuit, and the employment of one motor instead of two on a car. Probably in England, these matters have not assumed any great importance yet, but with us they press for settlement. Mr. Kapp should visit America, see what is being done, and then write his third edition.

We can heartily commend this book. It is clear, incisive and impartial; throws light on many difficult points, and brings the reader squarely abreast of the advanced thought or best practice of the day. As far as it goes, it cannot be excelled, and no other work goes as far as it does in dealing with what is the great topic of the times for electrical engineers,—the utilization of electrical energy.

Electrical Influence Machines. By John Gray, B. Sc. New York, *D. Van Nostrand Co.*, 1890. 287 pages, 89 illustrations. Price $1.75.

STATIC electricity is not a branch of study that is specially favored in these days of heavy electrical engineering, when the whole tendency of practical work is toward the building of big dynamos and the handling of enormous current, but it has its place, and no one can safely assume that it may not at an early period regain some of the prominence and the interest that it had in times gone by. Indeed, the recent researches of Hertz, as well as the fascinating and suggestive experiments of Lodge, would indicate that the neglect of static electricity is likely to be succeeded by an intense concentration of thought and work upon it, opening up boundless fields of investigation for the scientist while providing new careers for the electrician and electrical engineer of the twentieth century.

The first portion of this excellent book unfolds the modern theories of the subject, Chapter 1 dealing with its experimental data and Chapter 2 giving us a "working hypothesis of the electric field." A separate chapter is devoted to electrometers, and Sir William Thomson's beautiful inventions receive therein their due share of attention. Part II is mainly historical and descriptive, and brings the record of evolution and improvement down to date. It is interesting to note that America is conspicuously absent from this review, although we observe a passing reference to the large Holtz influence machine built in this city by J. and H. Berge, with two rotating discs each 45 inches in diameter and yielding a 26-inch spark. Part III is admirable in the fullness and clearness of its details as to the actual construction of Wimshurst, Holtz and Voss machines.

BOOKS RECEIVED.

Spon's Tables and Memoranda for Engineers. By J. T. Hurst. Tenth edition. New York: *E. & F. N. Spon*, 1889. Price 40 cents. (Vest-pocket size).

Practical Electrical Notes and Definitions. By W. P. Maycock. New York: *E. & F. N. Spon.* 130 pp., illustrated. Price 60 cents.

Practical Electrics. A Universal Handy-Book on Every Day Electrical Matters. New York: *E. & F. N. Spon.* 135 pp., 5⅛ x 8¼, illustrated. Price 75 cents.

Inventor's Manual. New York: *J. F. Davison & Co.*

J. A. Berly's Universal Electrical Directory. London: *Wm. Dawson & Sons.* Ninth annual edition. 506 pp. Price $3.

Electricity in Modern Life.—By G. W. De Tunzelmann, B. Sc. Scribner & Welford, 743-745 Broadway, New York, 1890. Illus. 272 pp., cloth. Price, $1.25.

Lecons sur l'Electricite, Vol. I.—By Eric Gerard, Director of the Institute Electro-Technique Montefiore, of Liége. Gauthier-Villars et Fils, Paris, 1890. 558 pp., paper.

Die Zeittelegraphen und die elektrischen Uhren vom praktishen Standpunkte.—By Ladislaus Fiedler. Electro-technische Bibliothek, vol. XL. A. Hartleben. Vienna, 1890. 207 pp., paper. Price, $1.

Le Magnetisme Humain Considere comme Agent Physique.—By H. Durville. Librairie du Magnetisme. Paris, 1890. Pamphlet, 36 pp. Price, 25 cents.

Application de l'Aimant (Magnetisme Mineral) au Traitement des Maladies.—By Professor H. Durville. Second edition. Librairie du Magnetisme. Paris, 1890. Paper, 63 pp. Price, 35 cents.

Almanach-Annuaire de l'Electricite et de l'Electrochimie.—1890. France, Belgium, Switzerland. Firmin Leclerc. Paris, 1890.

SOCIETY AND CLUB NEWS.

CHICAGO ELECTRIC CLUB.

The following is the regular ticket for officers to be chosen at the annual election:—

President, F. G. Beach; vice-presidents, 1st, F. B. Badt; 2d, Alex. Kempt; 3d, D. P. Perry; 4th, W. H. McKinlock; secretary, W. A. Kreidler; treasurer, F. S. Terry; managers, B. E. Sunny, M. A. Knapp, F. W. Cushing, Geo. O. Fairbanks, Wm. Taylor, F. E Degenhardt, E. Baggot, F. W. Parker, Geo. C. Bailey, C. H. Wilmerding; membership committee, C. C. Haskins, Geo. Cutter, W. B. Pearson.

NEW YORK ELECTRICAL SOCIETY.

The society enjoyed a most delightful and successful reunion at the Lenox Lyceum Electrical Exhibition on April 25. Through the kindness of Mr. A. B. de Freece, the manager, a reduction in admission price was made, and Mr. George H. Guy, secretary of the society, had the pleasure of welcoming some 250 of the members and their friends. The tickets admitted to every thing, a special musical programme had been provided, and every body was more than satisfied with the artistic, scientific and intellectual treat.

NEWS AND NOTES.

ELECTRIC LIGHT AND POWER IN SEATTLE, WASH.

MR. E. C. KILBOURNE the president and manager of the Pacific Electric Light Co. of Seattle, writes us as follows:

"Our plant is now being installed, poles are up for two of the circuits and are rapidly being placed in position all over the business part of the city. We expect to be running May 1 with one 1,300-light Thomson-Houston alternating incandescent and one 45-light Thomson-Houston arc machine. The present outlook is that before we have been running 60 days we will be obliged to double our capacity. We are expecting to increase our power plant immediately by the addition of two large boilers and one 250 h. p. engine. In regard to electrical business generally in this city I will say that there are four electric light companies, including our own, with capacity for 600 arc lights and a little less than 7,000 incandescent lights, including 800 municipal incandescent lights. There are two electric railways already completed and in operation and one more building, and a power company furnishing power for stationary motors. Nearly all the printing presses in town are now being run by electricity. The rapid growth of Seattle keeps the electric companies busy meeting the demand for light, power and electric railways."

The Pacific Company will start with 10 miles of circuit. It is now in the market for its new engines and boilers. The other officers of the company are C. A. Kilbourne, secretary and C. P. Stone, vice-president and treasurer.

AN INDEPENDENT TELEGRAPH COMPANY PROPOSED IN CHICAGO.

A special dispatch from Chicago, of April 16, says: Whether or not the construction of a commercial telegraph line between Chicago and New York will be commenced within thirty days depends on the answer of Colonel R. W. Clowrey, First Vice-president of the Western Union Telegraph Co., returns to the demand made by the Board of Trade Committee to day that the forty-cent rate between the two cities be reduced to 25 cents.

The high rate went into effect April 1, when the telegraph company was forced to withdraw its offices from the floor of the board, when the war against the bucket shops was begun. At a meeting of members, recently held, a committee, consisting of Robert Lindblom, A. Poole, and C. F. Dwight, was appointed to secure a return to the old rate or put in operation a telegraph company which would construct a line to New York. The committee made its demand of Superintendent Tubbs to-day, but he said that in the absence of Mr. Clowry he could not return any answer to the committee. Mr. Clowry will not return until next week.

But the committee does not propose to be played with. At a meeting the subject of a new line was thoroughly investigated, and it was decided that the necessary money for its construction could be procured without trouble, and if the Western Union refuses to make a twenty-five-cent rate the committee decided to go ahead and form a company to build the line. As the committee consists of the same men who several years ago built a line to Milwaukee, their action means business.

A SOUTHERN TELEGRAPH TOURNAMENT.

A special dispatch from New Orleans of April 21, says: A large number of ladies and gentlemen assembled at the Board of Trade rooms yesterday afternoon to witness the first southwestern telegraph tournament under the management of Mr. E. J. Davis. In the sending contest speed, accuracy, and Morse were the points to be decided; each participant sent for five minutes.

The winners of the first prizes were W. S. Brewer, 211 words, superior Morse; J. B. Griffin, 194 words, superior Morse, and W. R. Wallis. The last named took first prize for receiving on typewriter in manifold. Brewer and Wallis are attachés of the Associated Press in this city.

. . . ELECTRICITY has now become in the words of a distinguished physicist, "a truly imperial science," in which physics and chemistry may be said to occupy the position of mere subordinate provinces.—*John Gray.*

. . . . THERE are two requirements with regard to the material suitable for aerial lines which are to a certain extent contradictory. The specific resistance of the material should be very low, and its tensile strength very high.—*Gisbert Kapp.*

OBITUARY.

Charles W. Jenks.

Mr. C. W. Jenks, who died April 9, was so widely known in electrical and manufacturing circles, that a sketch of his life presents more than ordinary features of interest. Colonel Jenks, as he was called by his friends and business acquaintances, was born at Southbridge, Mass., April 24, 1826. He was the son of Dr. Nicholas Jenks, a physician of reputation, a well known temperance and anti-slavery worker, and was one of a family of seven, of whom Professor J. W. P. Jenks, who has attained eminence in the scientific world as an authority on zoology, was for 30 years principal of Pierce Academy, Middleboro, Mass., and has for several years past occupied the chair of Natural History and Curator of the Museum at Brown University, Providence, R. I. The opportunities which Colonel Jenks enjoyed for obtaining an education were very limited. At 20 years of age he was employed in one of the hotels of Boston, and for 10 years was known as the most popular clerk in the city, being connected successively with the old Pavilion, Marlboro and Adams Houses. Here he laid the foundation of personal friendships with some of the most prominent public men of the time, and many of these acquaintances have been revived in the later years, with the events of which his friends of this decade are more especially interested.

After a dozen years of mercantile life he was first brought prominently before the public in connection with national affairs in 1869, by his editorship of *The Bureau*, a monthly journal published in Chicago, and devoted to the advancement of protection and the manufacturing industries of the West. By graphic and brilliant editorial articles, a new impetus was given to several growing branches of trade.

At that time the subject of Arctic exploration attracted wide attention, and the late Captain Silas Bent, of St. Louis, formerly of Commodore Perry's staff, on the famous expedition to Japan, became much interested in the views of *The Bureau* on the subject, and opened up a correspondence with the editor which ended in a firm and valued friendship. The course of the Gulf Stream and thermal winds as relating to meteorology being fully discussed, Mr. Jenks was led to take up the subject in connection with the shipping in our ports, in a series of articles which attracted the attention of President Grant, who called Mr. Jenks to Washington for a conference with him upon the subject, the result being the establishing of our present Signal Service system. Through the medium of *The Bureau*, a property in Missouri, which contained pure white sand was purchased by Mr. Jenks for the late Captain E. B. Ward, of Detroit, and a plate-glass industry—the first in this country—was successfully established in 1871, at what is now known as Crystal City, on Platin Creek. This has grown to large proportions, turning out as fine a quality of glass as can be made abroad, and greatly cheapening the commercial product. At the time of the Chicago fire, *The Bureau* office was destroyed, and he lost both business and home by the great conflagration.

Needing for the glass industry an abrasive, he next turned his attention to looking for such a polishing material, and in 1871, found in Macon County, near Franklin, North Carolina, a deposit of corundum which he opened and worked—the first instance of legitimately mining corundum in the history of the world.

The year following (1872) his energetic research disclosed to science for the first time the true oriental corundum gems (sapphire, ruby, emerald, topaz and amethyst) *in situ*, previously found only in the washings of the streams of the far east. On the occasion of a visit to Europe with some of these specimens, he was cordially received by Professor Forbes, as bearing new information in this branch of science, and delivered an address before the Royal Geological Society, the Duke of Argyll presiding. He afterward developed another corundum mine in the same vicinity, and these two are to-day the only paying mines of that character on the American continent.

In 1875, he connected himself with the National Association of Wool Manufacturers, as an assistant to the secretary, the late Hon. John L. Hayes. From that time he devoted much attention to the introduction through the South and West of thoroughbred Merino sheep and the Angora goat husbandry, importing from Asia Minor pure blooded Angoras for the late Hon. Richard Peters, of Atlanta, Georgia, Hon. E. B. Bigelow, of Boston, and others. While with the Wool Association, he was often in Washington, in the interests of protection and tariff matters.

His deep solicitude for the progress of the industries of the country led him to investigate the condition of affairs at the South, coming in contact with many prominent men of that section, and interesting himself in its growth and resources. As a result he believed in bringing northern and southern men face to face, and following this idea he was the principal agent in attracting Gen. Gordon to Boston, in 1878, where as will be remembered, a royal welcome was given, such as it was never dreamed northern men would accord to a southerner. The good to both sections can never be computed.

In 1878 Colonel Jenks engaged with the Brush Electric Light Co., doing pioneer work in Boston in the sale of the first commercial plant to the clothing firm of Freeland, Loomis & Co., and taking personal charge of the placing and operating of the Brush exhibit at the first Mechanics' Fair (1878), on the occasion of the memorable test when several learned scientific "experts" decided that a machine, of which it is said not another was made, was superior to the Brush. For about four years he worked early and late in introducing the Brush apparatus, thus assisting in laying the foundations of that enormous business, and the general industry of commercial electric lighting.

In 1882 he came to N. Y. as editor of the *Industrial Record*, filling that position with eminent ability, and to the satisfaction of the patrons of that journal. Active business being more to his taste than editorial duties, and preferring Boston for a home, he yielded to the importunity of a friend who was connected with the Standard Paper Bag Co., and accepted the management of that enterprise, only to see all destroyed by fire just as he had systematized the business. The company did not rally, and he next engaged with F. A. Lockwood of the Lockwood Mfg. Co., East Boston, in the interests of the Cape Cod Ship Canal Co. in 1884, rendering that corporation valuable services through his acquaintance with prominent men, and interesting in the plan such capitalists as General C. C. Dodge of this city.

In 1887 he came to New York with the Sprague Electric Railway and Motor Co., and in the infancy of the enterprise, put into the preparation of their advertising literature, and the development, amid many difficulties, of their Department of Mills and Mines, all the enthusiasm of his earlier years, and all the results of his long business experience and ability as a writer and correspondent. But unremitting and largely unrequited labor for many years had broken his strong constitution, and early in March he was suddenly missed from the office, and though apparently improving at the residence of his son—Mr. W. J. Jenks, of the Edison General Company—at Nyack on the Hudson, dropped without warning and lived scarcely an hour.

Colonel Jenks was a man of remarkable versatility. For years he has been recognized as the first living mining engineer in the department of corundum and its gems. He was often referred to in the literature of the textile industries as the best authority in America on Mohair and the Angora goat. He had within three years acquired an exhaustive knowledge of the commercial application of electric motors to mining operations, and his foresight and persistent effort brought about the invention by Mr. Edison of a percussion rock drill. As an editorial writer he had few superiors in his specialties, articles from his pen often finding their way even during the later and busiest years, into the technical journals of the textile and electrical arts. His command of terse vigorous English, in speaking as well as writing, was recognized wherever he was known. He was a patient and tireless worker, and his was throughout the life of a pioneer, sowing the seed of one enterprise after another, from which others reaped the harvest.

He was a recognized art critic, and was the means of encouraging and building up several of those whose names are well known as American painters. He was also an accomplished Bible scholar, and a course of lectures delivered 30 years ago was warmly commended by Wendell Phillips and others, and is even now referred to as unique and exceptionally instructive in its treatment of the history and customs of eastern lands.

He was ever a gentleman, courteous to all, and generous even beyond his means. His strong belief in the integrity and honesty of mankind often worked to his own disadvantage. He leaves a widow (a second marriage) and eight children, of whom five are sons in active business life, one having been identified with telegraph, telephone and electric light interests since 1872 and now connected with the legal department of the Edison Electric Light Co. in this city; another in the offices of the Sprague company; and two identified with the development of the real estate and mining interests of the South at Asheville, N. C.

...If we would judge fairly of the merits of a new invention we should not only look upon it by itself, but compare it with all that has gone before and might be superseded by it.—*Gisbert Kapp*

....It is a popular but erroneous belief that great inventions have sprung, full-grown and completely equipped, from the brain of their inventors, like Minerva from the brain of Jupiter.—*John Gray.*

....It is this peculiarity of electric transmission, that the power consumed is always proportional to the work performed, which renders it on the whole more economical than some other and purely mechanical devices.—*Gisbert Kapp.*

.... There are two troubles which beset most accumulators viz., buckling of plates and bad forms of sulphating. To these all other difficulties, with few exceptions, may be traced. Buckling is almost unknown in well-managed installations.—*Sir D. Salomons.*

....Without the use of hypotheses or antecedent probabilities as a general rule, no extended series of investigations can be made as to the approximate cause of casual phenomena. They require to be used, however, with great care, lest they become false guides which lead to error rather than to truth.—*Joseph Henry.*

LEGAL NOTES.

CIRCUIT COURT OF THE UNITED STATES— DISTRICT OF NEW JERSEY.

(April 12, 1890.)

THE HOLMES BURGLAR ALARM TELEGRAPH CO. AND THE MUNICIPAL DISTRICT TELEGRAPH CO. *vs.* THE DOMESTIC TELEGRAPH AND TELEPHONE CO., GEORGE W. HUBBELL, ENOS BUNYON, E. T. FEAREY, AND JABEZ FEAREY.

Wales—*J.* This suit was brought to restrain the defendants from infringement of re-issued Letters Patent No. 4,297 for improvements in electro-magnetic burglar alarms, granted March 14, 1871, to William B. Guernsey. One of the complainants is the owner of the patent, and the other is alleged to be a licensee under it.

The bill sets out the title of the Holmes Burglar Alarm Telegraph Company, and the granting of an exclusive license for certain purposes to the Municipal District Telegraph Company; but objection is made, in the answer of the defendants, that, in fact, no license was ever granted to the Municipal District company, and in consequence of the absence of joint interest and privity between the parties complainant. the bill should be dismissed on account of this misjoinder. Waiving a consideration of the question whether this objection should not have been taken by a plea in abatement, it is sufficient for the present purpose to say that the testimony of the witness, Holmes, and the written agreements in relation to the ownership and use of this patent, which are set out in the complainants' exhibits, afford satisfactory proof that a license was given to the Municipal District Company, as is alleged in the bill. The granting of a license may be proved by the acts and dealings of the parties who own and permit others to use the patent, without the necessity of resorting to written instruments, and it clearly appears from the proofs that prior and up to the time of bringing this suit, the Municipal District Company had been treated and acknowledged as its license by the owner of the patent. This inference of fact is drawn from the transactions which were had between the Holmes Burglar Alarm Company, and its immediate licensee, the Protective Company, which latter company transferred its license to the Municipal District Company. Admitting, as it is claimed by the defendants' counsel, that the license to the Protective Company was personal only, and not transferable, and that it had not, prior to its assignment to the Municipal District Company, any right to assign its license, yet it is certain that the Holmes Burglar Alarm Company acquiesced in and ratified the assignment, and thereafter recognized the Municipal District Company as its licensee. There is no restrictive provision in any of the agreements which prevented the owner of the patent from conferring authority on the Protective Company to assign its license, and such authority may be proved without the aid of written articles. This conclusion dispenses with the necessity of discussing the regularity of the mode adopted by the defendants in presenting the objection of misjoinder, which, under the technical rule of pleading and Equity Rule 39, should have been taken advantage of by a plea in abatement.

Another preliminary objection, which is insisted on by the defendants' counsel, is that claim 2 of the original Guernsey patent, which is made claim 4 of the re-issue, is not covered by the oath of the inventor, and is therefore a nullity, and forms no part of the real patent. There is no evidence on this point, and there is equal ground for the presumption that the oath was taken as that it was not. But is the taking of the oath absolutely necessary? In *Whittemore v. Cutter*, Judge Story said, "the taking of the oath was but a pre-requisite to the granting of the patent, and in no degree essential to its validity." In *Crompton v. Belknap Mills* (3 *Fisher*, 536), the defendants, as in the present case, relied upon a certified copy of the file-wrapper and contents, to show that the oath had not been taken, but the Court said:

> We are not satisfied that the oath was not taken. The letters patent recite that it was. * * * "But suppose the oath was not taken; would the patent be void on that account? It was held otherwise by Judge Story. The taking of the oath, though to be done prior to the granting of the patent, is not a *condition precedent*, failing which the patent must fail. It is the evidence required to be furnished to the Patent Office, that the applicant verily believes he is the original and first inventor, etc. If he takes this oath, and it turns out that he was not the first inventor or discoverer, his patent must fail and is void. So, if he do not take it, still if he is the first inventor or discoverer, the patent will be supported.

It has also been held that this is not a matter to be inquired into collaterally in the infringement suit. Hoe *vs.* Kahler (20 Blatch. 430); De Florez *vs.* Reynolds (14 Blatch. 505); and in Railway Register Co. *vs.* North Hudson Co. the Court recognized the right of an applicant's attorney to insert in a pending application amended and enlarged claims "without having them verified by the oath and signature of the patentee provided only they relate to matter substantially shown and described in the specification." As to the oath it was decided in Seymour *vs.* Osborne (11 Wallace, 516), that recitals in letters patent that the required oath was taken before the same was granted, are, in the absence of fraud, conclusive evidence that it was so taken.

Original letters patent No. 103,257 were issued to Guernsey, October 11, 1870, and the re-issue for the same invention No. 4,297 were granted to him on March 14, 1871. The nature and objects of the invention are, in part, thus specified by the patentee, in the re-issue:—

> *The principal object of my invention is to provide an electrical apparatus which will give an alarm or an indication either in the event of the conducting circuit being broken or in the event of a new or shorter circuit being formed.* To this end I employ a continuous circuit or a circuit capable of being made continuous at will, arranged with *a resistance* or resistances, so that the current which is allowed to pass will not possess sufficient E. M. F. to effect the alarm, but having such arrangements at windows and doors and other places to be guarded as will, on any tampering therewith, short-circuit the currents past or around the said *resistance* or resistances to an extent sufficient to actuate the alarm. My invention thus combines the advantages and avoids the disadvantages of the two varieties of electro-magnetic alarms which are distinguished as the closed-circuit system and the open-circuit system.
>
> *I will proceed to describe a way of carrying out my invention by the use of two separate electro-magnets, each of which may constitute a resistance to prevent the sounding of an alarm until the circuit is either made around or past such resistance or broken. More than one magnet or resistance is not essential in carrying out the invention, as will be understood from the following explanation*:
>
> Fig. 1, shows, in perspective, two electro-magnets with separate conductors connected with a common battery. each conductor passing through an alarm, and through suitable connection devices, which may be located in the frames of windows, or at any desired points, in such manner that the opening of a door or window, or the performance of any act which it is desired to detect, will connect one conductor and avoid both electro-magnets. For this purpose the magnet of one conductor is located near the positive pole, and that of the other near the negative pole of the battery.
>
> Fig. 2, illustrates a modification, in which one magnet *may be* dispensed with and a simple resistance coil introduced *at the point to be protected* in such a manner that the act to be detected will close a short-circuit avoiding the resistance and thus sounding the alarm. This more simple form of the apparatus is applicable to places where a single window, door, or other object is to be protected.

Then follows a general description of the drawing.

> *Two magnets and two conducting wires are shown and described, but only one magnet or other electro-motor and one conducting wire is necessary to accomplish the same effect as will be manifest by an examination of the arrangement and a knowledge of the principles involved. The location, with regard to each other, of the various members or elements of the alarm is not an essential part of the invention and can be varied as circumstances dictate.*
>
> Where but a single place is to be protected, as, for example, for the vault-door of a bank, the apparatus may be simplified, dispensing with one of the resistance magnets and employing a simple resistance R, Fig. 2, *placed at the point to be protected*, and so arranged *with regard to the other members of the alarm* that the opening of the door or window, or the doing of any act which the alarm is to detect, will short-circuit the conductor by forming a connection between the wires, across or independently of the resistance.
>
> Various other modifications will readily suggest themselves for the accomplishment of the object without departing from the essential principles of the invention, the design being to obtain an alarm in which the signals shall be given by the closing or making of connection between two different conductors, or between two parts of the same conductor *essentially* as is done in the open or interrupted circuit alarms, while at the same time there is or may be a continuous circuit in the said conductor or conductors, which, by proper contrivances, may be made to give notice to the person in charge of said alarm of any injury, accidental or malicious, which may have happened to his instrument or its belongings.

The third and fourth claims of the re-issued patent are precisely identical with the first and second claims of the original patent, with the exception of the italicized words which have been inserted in the re-issue, and are as follows:—

> 3. The combination in an electro-magnetic alarm, of a continuous circuit or circuits, with a sufficient resistance or resistances, and an alarm or alarms, when the said combination is so arranged that the severing or interrupting of the said circuits, or of either of them, shall cause the said alarm or alarms to sound; and also, that the short-circuiting or diverting the course of the electrical current in said circuit or circuits around *or* past the said resistance or resistances shall sound an alarm, *or cause an alarm to be sounded*, this when the whole arrangement is properly combined with a sufficient battery, and with "connections" or contrivances at points to be guarded, which will, upon the doing of certain acts, or the happening of certain things, short-circuit the said electrical current or currents past or around the said resistance or resistances, and so give the desired alarm.
>
> 4. In a burglar or fire-alarm, the combination of an open and a closed circuit to operate substantially as set forth.

The third and fourth claims of the reissue have not been enlarged, and are identically the same with the first and second claims of the original, with the exception of the italicized words in the former which do not materially change their effect. The drawings accompanying both patents are the same. The specifications in the reissue are the same as in the original, excepting the italicized portions, and describe the nature and objects of the invention more clearly and plainly than is done in the latter, in order to cover any element to which, by a fair construction of the original, the patentee would have been entitled; and for this purpose a reissue has always been allowed when the patentee has, by inadvertence or mistake, omitted to make such a description in the original. A patentee can claim on a reissue whatever clearly appears to have been a part of his original invention as described or shown in his original specification, drawings or models, and Guernsey has done no more. *Battin v. Taggert* (17 How. 74); *Gallahue v. Butterfield* (10 Blatch., 232); *Wheeler v. Clipper Co.* (6 Fisher, 1); *Seymour v. Osborn* (11 Wall, 544); *Colkins v. Burtrand* (6 Biss., 494); *Russell v. Dodge* (93 U. S., 460).

The two prior systems referred to by the patentee were well known at the date of the patent, and had been in extensive use, but each had certain serious and recognized defects which it was the object of Guernsey's invention to obviate. The advantages and disadvantages of the old systems are thus stated by Professor Brackett:—

> The advantage of the open-circuit system is, that the apparatus cannot be disabled by connecting the two parts of the circuit together between the battery and the point protected, since such connection would sound the alarm in the same manner as opening the door or window. The disadvantage of this system is, that the circuit may be cut out or disconnected at any point without sounding the alarm, and this would completely disable the apparatus, since no alarm would be given upon a subsequent opening of the door or window. Such a system offers no difficulty to a burglar, except as the wires leading from the battery

> to the protected structure be effectually concealed, which might be difficult to do.
>
> The advantage of the closed circuit system is, that the line is protected against cutting or interruption, since such an act would sound the alarm, and its disadvantage is, that it may be completely disabled by forming a short circuit around the point protected, since this would not sound the alarm, nor would the alarm be sounded by any subsequent opening of the door or window.

It is thus apparent that each of these prior systems afforded sufficient protection as long as the wires or conductors remained intact, but both were fatally defective in that they could readily be disabled by tampering with the wires; and it was the object of the Guernsey invention to protect the wires or conductors from being tampered with, by any method applicable to either of these systems.

Mr. Pope thus states the general nature of the invention:—

> Guernsey was the first, so far as I am able to ascertain, from the evidence in this case or otherwise, to combine in one and the same organization of circuits, the characteristic signal instruments of both the open-circuit system and of the closed-circuit system with a resistance or resistances, in such a manner as to make the open-circuit instrument guard against disabling the apparatus by any method applicable to the ordinary closed-circuit system; and conversely, to make the closed-circuit instrument guard against disabling by any method applicable to the ordinary open-circuit system.

Both complainants and defendants are engaged in the business of central office protection, and, as it is alleged, make use of almost identically the same form of apparatus.

The defendants' apparatus consists of a battery, two principal instruments and their accessories, conductors connecting the battery and instruments with an electrical casing enclosing a safe, a resistance and contact-springs connected with the door of the safe-casing. Both instruments are included in the circuit, so that the current traverses their coils successively. One of them, designated as the "galvanometer" in the drawing (Complts. Exhibit No. 6), consists of a magnetized needle pivoted so as to swing freely in either direction in front of a coil through which a current passes. Its movement is limited by contact-stops, which form the terminals of a local circuit containing an alarm-bell B. The instrument is so constructed and adjusted, that when the resistance at the safe is included in the circuit, the needle stands between the two stops, but when the current is strengthened by short-circuiting the current past or around the resistance, the needle is swung, by the influence of the current in the coil, against the stop at the right, and an alarm is sounded on the bell B. It thus performs the function of the ordinary open-circuit instrument. In addition to this, when the circuit is broken, the needle swings against the stop at the left and rings the same bell. The other principal instrument, designated as a "relay" in the diagram, corresponds in all respects in construction and mode of operation to the ordinary closed-circuit instrument. By the intervention of two local circuits, it is made to release a drop or shutter and ring an alarm-bell C, when the current ceases to flow through its coils. There are two sets of contact-springs at the safe, so arranged that upon the first movement of opening the door, the circuit is broken at the springs J J' at the top, and an alarm is sounded upon both the bells B and C; upon opening the door a little farther, a short circuit is formed around the resistance coil R, through the wire G G, and the galvanometer swings to the extreme right and again rings its bell B. If any attempt is made to tamper with the apparatus by cutting either of the wires leading to the safe, an alarm is sounded both upon the galvanometer-bell B and the relay-bell C; and if the wires are short-circuited, an alarm is sounded on the galvanometer-bell B.

It is contended, on behalf of the complainants, that the defendants' apparatus, the operation of which is thus described, contains the gist of the Guernsey invention, since it contains instruments having the characteristic mode of operation of the instruments of the two old systems referred to in the patent, and these are combined in the same circuit with a resistance so arranged as to render both instruments operative. The result of this combination is, that the wires leading to the safe are effectually protected both from interruption and from short-circuiting. In other words, the same result is produced by substantially the same means in defendants' apparatus as in the apparatus of the patent.

It is conceded that the use of a galvanometer-needle, such as used in the defendants apparatus, to open and close a local circuit, including an electric bell, was well known in the art prior to the date of the patent, and that the galvanometer was recognized as an equivalent, for that purpose, of an electro-magnet and armature such as is shown in the patent. It is urged by the defendants that the galvanometer is made to perform an additional function in their apparatus, but this fact will not relieve them from the charge of infringement, so long as all the elements of the complainants' patent are embraced in their system. *Williams v. Barnard* (41 *Fed. Rep.* 364.)

A careful examination of the testimony, which displays a special knowledge of the art united with unusual intelligence and ability on the part of the witness, leaves no doubt that the defendants are infringers of the third and fourth claims of the reissued patent. An elaborate review of the testimony with references to the numerous models and diagrams contained in the exhibits, would extend this opinion to an unreasonable length, and under the circumstances of the case is not necessary.

The validity of the reissue was vigorously attacked on the ground of its alleged variances from the original patent, and chiefly because the latter does not contain even a suggestion of a single-circuit form of apparatus; but a comparison of the specifications and drawings of the two patents does not sustain this objection. Fig. 2, in the drawing of each patent, shows a single wire, and if by mistake or accident the original specification did not describe with sufficient plainness the use and application of this wire, it was permissible to the patentee, under the provisions of the Act of Congress relating to reissues, to supply the omission as soon as it was discovered, and this he did within a few months after the date of the original. The single circuit was clearly indicated in the original, and by a fair construction the patentee would have been entitled to its use. As already shown, the claims in suit were not enlarged in the reissue. In fact the fourth claim is restricted, by the words "to operate substantially as set forth."

It is further insisted on by the defendants, that the patent in suit does not contain a patentable combination, in that it is only an aggregation of old parts of elements, which act successively and not simultaneously.

The simultaneous co-operation of the parts is not essential to a patentable combination if the parts are so arranged that the successive action of each contributes to produce some one practical result, which result, when attained, is the product of the simultaneous or successive action of all the elementary parts, viewed as one entire whole. The term co-operation does not mean acting together or simultaneously, but unitedly to a common end. *Birdsall v. McDonald* (1 *B. & A.* 165); *Forbush v. Cook* (2 *Fish.* 668); *Hoffman v. Young* (2 *Fed. Rep.* 77). So here, the electrical protection of the conductors is the result produced by the combination, and the two instruments guard the same line at the same time. One instrument protects it from cutting and the other from short-circuiting. Remove either instrument and the result fails *pro tanto*. This result was useful and never before known. The design of the combination was to protect the patented apparatus against the methods of disabling it, by tampering with the conductors, as could be done with the prior systems. The instruments co-operate in making good each other's deficiencies, and the arrangement of the conductors is such that all their essential parts are brought under the protection of the instruments. To this end the resistance co-operates with the closed-circuit instrument by forming a path for the current when the apparatus is in its normal condition, so that a continuous current may flow through the conductors and through the instrument without giving an alarm; it co-operates with the open-circuit instrument by enfeebling the current to such an extent that the open-circuit instrument is not called into action until a short circuit is formed, and the current thereby increased. In view of the authorities, this constitutes a patentable combination, leading to a new result by new means.

But the defendants have introduced certain prior English patents, which, they say, embrace substantially the same elements as are found in the patent in suit and thus deprive Guernsey of the claim of originality. It is not asserted that the inventions contained in the English patents are identical with that of the Guernsey patent, but that in the state of the art at the date of the Guernsey original patent, it required only simple modifications and substitutes in the English devices, to make them produce the same results as are secured by the Guernsey combination. The English patents referred to are those of Tyer (1865), Varley (1865), and Moxon (1266). The device of Tyer is an apparatus for transmitting signals indicating the position of trains upon a railway, and his patent contains no suggestion that it could be adapted to perform the office of a burglar-alarm; it can be easily disabled by cutting one of its wires, and is thus incapable of effecting the result secured by the Guernsey invention, which is the electrical protection of all parts of the conductors between the signal-instruments and the points to be protected. The Varley apparatus is a modification of the ordinary closed-circuit system, and does not contain any instrument corresponding to the signal instrument of the open-circuit system, or any other means of giving an alarm which is operated by an abnormal strengthening of the current, nor does it contain a resistance separate and distinct from the instruments; and it can be entirely disabled, if used for central-office protection, by inserting a battery in some part of the line leading from the circuit-closer to the alarm instrument. The Moxon patent would also require substantial alterations to make it accomplish the results which are obtained by the Guernsey combination.

The proposed modifications and substitutions would be in the nature of invention, and are not such as would readily occur to any one skilled in the art. They do not consist merely in the substitution of one known equivalent for another without any change in the resulting mode of operation, but it is proposed to substitute for one or the other of the elements of the prior combination something having a different or additional function, which amounts to the same thing as adding to the combination a new and distinct instrument, and makes it a new combination having functions that it did not before possess. Defenses of this character have been frequently discountenanced by the courts. *Wooster v. Black* (8 *Fed. Rep.* 429); *Dudgeon v. Watson* (29 *Fed. Rep.*

248); *Asmus v. Alden* (27 *Fed. Rep.* 684). Here, as in *Dudgeon v. Watson*, the defendants had used practically the same combination as is covered by the Guernsey patent, and subsequently made the changes by which they sought to escape infringement, but in that case the Court held that the defendants accomplished the same result by similar or equivalent means.

Among other objections to the Guernsey reissue it was urged that no interference was had between the reissue application and the Holmes & Roome patent of December 20, 1870; but there is no proof that Holmes & Roome were the prior inventors; on the contrary, the invention claimed in the Guernsey reissue was shown and described in the Guernsey original patent, which ante-dates any date of Holmes & Roome. The English patent, to Holmes & Roome, although dated as of November 1, 1870, was not in fact issued until April 2, 1871; the date at which the great seal was attached, and therefore the provisions of section 4,887 of the United States Statutes do not attach to the corresponding patent issued by the United States. The English patent to Holmes & Roome not being sealed, was not in existence until after the date of the Guernsey patent. *Gold & Stock Tel. Co. v. Commercial Tel. Co.* (23 *Fed. Rep.* 340).

The able and ingenious argument of defendants' counsel created, at first, some doubts of the validity of the Guernsey reissue, but after a careful consideration of the various objections presented by him, both orally and in his printed briefs, the conclusion has been reached that Guernsey was the original inventor of the combination claimed by him, and that the reissued letters patent are valid. A decree will be entered for the complainant, excepting as against the individuals named as defendants, in relation to whom there is no proof that they were personally guilty of infringement.

PATENT OFFICE INTERFERENCE.

EX-PARTE MEUCCI.

In the case of *ex-parte Meucci*, decided March 26, it appears that Antonio Meucci filed an application December 8, 1883, for a patent for a sound telegraph which was in fact a speaking telephone. It was proved that in 1871, a caveat had been filed by the applicant which was claimed to exhibit the invention embraced in the application, which caveat was renewed in 1872 and in 1873, and was then allowed to lapse. The case came up on a motion for rehearing, applicant averring that in the former decision of Commissioner Hall, he had erroneously held that applicant was barred by two years' public use prior to this application; that such public use had been established, and was in error in not passing Meucci's application to patent, so that an interference might be declared therewith. Commissioner Mitchell held that a caveat is not an "application" within the meaning of the statute; that the primary examiner was right in taking judicial notice of the fact that the telephone had been in public use more than two years prior to December 8, 1883, and that no attempt had been made by the applicant to disprove the fact; and that there is no statute authorizing an interference where the application of the party demanding such interference has been rejected by the primary examiner and the examiners-in-chief. The motion was accordingly denied.

GREAT WESTERN TEL. CO., E. R. BOWEN, RECEIVER, VS. HIRAM PURDY.

The case of the Great Western Telegraph Company, E. R. Bowen, receiver, vs. Hiram Purdy, was decided in the District Court, Burlington, Ia., on April 19. This case is of great importance to many citizens of Iowa. In 1867 to 1869 many citizens of the State subscribed to the capital stock of the company, or at least believed they so subscribed from the representations made to them by the agents at the time. The company soon thereafter contracted a large indebtedness and being insolvent passed into the hands of a receiver in 1874. In 1886 an assessment of 35 per cent of the stock was made by the court at Chicago, and the receiver brought this, the first action in Iowa to collect the amount. The intention is to sue all the subscribers in Iowa. There were many defenses pleaded and the issues involve many intricate questions of law. Judge Phelps gave the case a thorough consideration and decided in favor of the defendant. The case will probably be taken to the Supreme Court as a test case by the receiver.

THE WESTINGHOUSE ELECTRIC RAILWAY COMPANY.

The following is the circular now being issued by the above company, announcing its appearance in the field. It bears the signature of Mr. H. McL. Harding:—

We especially desire to call your attention to the Electric Railway System of the Westinghouse Electric Railway Company of Pittsburg, Pennsylvania. This system consists of constant potential dynamos and motors of five hundred volts, by the overhead method, and includes all the latest and most improved devices, many of which are peculiar to this company. There are no radical departures from the existing methods of electric street car propulsion, but great improvements in the details of mechanical construction and workmanship, the superiority in this branch of manufacture is the result of many years' practical experience in the building and operating of electric plants in every section of the country, and this experience of the companies allied to and controlled by the Westinghouse Electric Company, such as the United States, Sawyer-Man, Consolidated Electric Company, dates back as far, if not farther, than any companies now in the field constructing electric machinery. In addition to this the reputation of all work turned out by the Westinghouse Company for the best mechanical construction is so well known as not to need repetition here. One well-known street railway president said: "If George Westinghouse is going to build motors for street railway work, we can feel confident that the practical mechanical workmanship will be what has been so desired by street railway men. In most of the roads I have examined there has been a criminal negligence in this respect." All parts of the motors are made exceptionally strong, the bearing and working parts of great width, in short the strength of all parts conduce both to durability and the absolute certainty of regular daily operation.

The question of insulation has also received great attention and the perfection that has been attained by the Westinghouse Company in the manufacturing of their alternating dynamos in this respect, which from the peculiarity of the alternating current requires far greater skill than the direct current, is a guarantee in itself that this important feature is all that can be desired.

This company is not connected with any trust or combination of companies, and is able to quote you prices on whatever dynamos, motors or line material you may require, and promises in advance that the prices will appeal to you as being fair and just. Mr. H. McL. Harding, formerly General Agent of the Sprague Co., Mr. J. L. Barclay, the Western Representative of the same company, and Mr. C. C. Warren, District Manager of the Edison Company, are associated with this company.

The Westinghouse motors can be operated on any existing lines of electric street railways and the dynamos in connection with those already installed. The company are now ready to deliver motors and dynamos promptly after the orders are given, and will guarantee their machinery in every particular.

INVENTORS' RECORD

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 22, 1890.

Alarms and Signals:—*Bell and Engine Indicator for Pilot Houses of Steam Vessels*, W. E. Hadlock, 426,009. *Electric Signaling Apparatus for Hotels*, J. J. Miller, 426,134. *Thermostat*, J. P. McMahon, 426,304. *Electric Annunciator-Call*, W. S. Paca, 426,307.

Conductors, Insulators and Conduits:—*Insulated Joint*, E. F. Gennert, 426,121. *Apparatus for Hauling through Electric Cables*, J. F. Munsie, 426,196. *Underground Conduit*, J. F. Munsie, 426,197. *Insulator*, J. F. Munsie, 426,198. *Duct for Electric Conductors*, J. F. Munsie, 426,199. *Flexible Connector*, J. F. Munsie, 426,200. *Insulating Lining*, J. F. Munsie, 426,201. *Insulating Compound*, J. F. Munsie, 426,202. *Insulator*, J. F. Munsie, 426,203. *Binding Post*, J. F. Munsie, 426,204. *Duct for Electric Conductors*, J. F. Munsie, 426,205. *Man-Hole for Underground Electric Conductors*, J. F. Munsie, 426,206.

Distribution:—*Safety-Connection*, E. Thomson, 426,082. *System of Electrical Distribution*, C. J. Kintner, 426,127. *Converter*, E. Wagemann, 426,153.

Dynamos and Motors:—*Electric Machine for Covering Wire, &c.*, F. E. Davis, 425,990. *Electric Motor*, F. E. Davis, 425,991. *Safety Device for Dynamos*, E. P. Clark, 426,108, 426,109 and 426,110. *Dynamo Electric Machine*, M. J. Wightman and E. Thomson, 426,348. *Electric Motor and Dynamo*, J. C. Henry, 426,380.

Lamps and Appurtenances:—*Incandescent Electric Lamp*, J. W. Packard, 426,055. *Electric Lamp Hood and Support*, E. P. Warner, 426,155.

Measurement:—*Current-Indicator*, F. B. Rae, 426,065. *Armature for Electric Meters*, O. B. Shallenberger, 426,335.

Miscellaneous:—*Electric Fan*, P. Diehl, 425,995. *Magnetic Circuit-Closer*, J. von der Kammer, 426,021. *Electric Switch*, J. P. Norton, 426,049. *Fuse-Block*, T. Patterson, 426,057; *Fuse Block*, F. G. Warrell, 426,156. *Lightning Arrester*, A. D. Spear, 426,338. *Electric Gas Lighter*, C. H. Hinds, 426,381.

Railways and Appliances:—*Trolley-Support*, F. B. Rae, 426,066. *Electric Railway Contact*, F. O. Blackwell, 426,102. *Electric Railway System*, L. Gutman, 426,269. *Coupling for Electric Cars*, L. Pfingst, 426,317. *Electric Railway Car*, J. C. Henry, 426,379. *Electric Railway*, R. M. Hunter, 426,382. *Apparatus for Electric Railway Signaling*, C. H. Rudd, 426,395.

Secondary Batteries:—*Process of Manufacturing Electrodes for Secondary Batteries*, L. Epstein, 425,999.

Telegraphs:—*Electro-Magnetic Instrument*, P. B. Delany, 426,247.

Telephones and Appliances:—*Coin-Controlled Apparatus for Telephones*, W. Gray, 426,266.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

ANOTHER SOUTHERN SPRAGUE ELECTRIC RAILWAY.

We note with interest in a list of recent Sprague railway contracts furnished us by the Sprague Electric Railway and Motor Co. that a number of these come from Southern States.

This portion of the country has been up to this time rather slow in adopting methods for street railway propulsion, but the fact is evident that this slowness is growing less continually. One of the largest of these contracts made by the Sprague company is that with the Augusta Street Railway, the principal street railway in Augusta, Ga. The equipment of this road, which will be in operation before very long, will be first class in every respect. The cars to be equipped with electric motors are 16 in number, and each will carry two 15 h. p. motors. At the station, the generating plant will consist of two 30,000 watt dynamos for supplying the necessary current for the line, which will be more than 15 miles in length. The line of route passes the Union Depot, Opera House and the principal points of interest in the city.

After leaving the heart of the city, the street car tracks are laid in the centre of the boulevard in the residential districts in which the roadway lies on each side.

The centre strip, which occupies a space of 60 feet between the roadways, contains a double row of large elm trees running the entire length of the boulevard, so that the poles required for span work are almost entirely hidden by the foliage, and are so rendered unobjectionable even to the most critical eye. The space between the tracks will be covered with turf, so that the tracks will not be noticeable at a little distance. It is hoped that 5 cars will be in operation by May 15, and the rest of the equipment will be in operation by June 15.

INSTALLATIONS OF C. & C. MOTORS.

The C. & C. Electric Motor Company, of 402 Greenwich st., this city, have to report the following sales: Edison Electric Illum. Co., Brooklyn, one 3 h. p. for ventilating station and one ⅛ h. p. fan outfit; one 1 h. p. to Pennsylvania R. R. shops, Altoona, Pa.; one 10 h. p. to American Press Association, Chicago, Ill.; one 1 h. p. to Messrs. Gahl & Lembke, 21 Union sq., New York; one 2 h. p. to T. H. Porter, Stamford, to run elevator; one 2 h. p. to Edison Electric Illum. Co., Newport, R. I.; one 10 h. p. to *Sunday Telegram*, Harrisburg, Pa.; one 1 h. p. to First Presbyterian Church, Easton, Pa.; one 1 h. p. to J. H. Simpson, 154 W. 23d st., N. Y., to run ventilating fan; one 3 h. p. to Edison Electric Illum. Co., 432 Fifth ave., N. Y.; one 8 h. p. to the Solomon Lord building, 18th st. and Broadway, running elevator; one 1 h. p. to Thompson's, 25 East 14th st., N. Y., running ventilating fan; one 1 h. p. to Warren & Witherell, 201 Hanover st., Boston, Mass., to run coffee grinding machine; one 2 h. p. to St. Thomas' Church, 53d st. and Broadway, N. Y., to run ventilating fan; one 1 h. p. to Edison Electric Illum. Co., Fall River, Mass.; one 1 h. p. to C. M. Gage, Champion Card and Paper Co., Pepperell, Mass.; one 5 h. p. to Fletcher & Co., Portland, Me., to run elevator; one 5 h. p. to Dr. Kilbourne, pres. of Seattle Electric Railway & Power Co., Seattle, Washington; one 2 h. p. to Ryan Bros., Appleton, Wis.; one 1 h. p. to *Court Journal* Publishing Co., 608 F. st., Washington, D. C., to run press; one 2 h. p. motor to B. F. Robinson, 21 Broadway, Lawrence, Mass., to run lathe; one 5 h. p. to Fell & Josephs, Wilmington, Del., to run elevator; one 4 h. p. to Bradley Fertilizer Co., North Weymouth, Mass.; one 4 h. p. to Allen & Kenway, 220 Devonshire st., Boston, Mass., to run ventilating blower; one 2 h. p. to Howard & Co., 264 Fifth ave., N. Y., to run jeweler's lathe and polishers; one 1 h. p. to Trinity Church, Easton, Pa.; one 3 h. p. to Whiting Mfg. Co., Union sq., N. Y., to run jeweller's lathe and polishers; one 4 h. p. motor to Professor C. A. Young, Halsted Observatory, Princeton, N. J., to turn observatory dome; one 5 h. p. to Fraser & Chalmers, Salt Lake City, Utah, to run a dynamo; one 3 h. p. motor to Leighton & Wilson, Phœnix building, Salem, Mass.; one 2 h. p. motor to Kobe, Japan; one 5 h. p. motor to G. B. Grant, 137 Franklin st., Boston, Mass.; one 15 h. p. motor to Snyder & Black, 92 William st., N. Y., to run lithographic and printing presses; one 1 h. p. to Wickstead Umbrella Co., 47 John st., N. Y., running machine shop; one h. p. to Church of Holy Communion, 6th ave. and 20th st., N. Y.; one 3 h. p. and one 10 h. p. to W. R. Danderson, 194 Water st., N. Y., running printing presses; one 10 h. p. to Trask Milling Machine Co., 118 South st., Boston, Mass., running machine shop; one 1 h. p. Southern District Telegraph and Electric Co., Birmingham, Ala., to run printing presses; one 1 h. p. to Roanoke Electric Lt. and P. Co., Roanoke, Va., used in printing the *Roanoke Daily Herald;* one 1 h. p. to General Society of Mechanics and Tradesmen, 18 E. 16th st., N. Y., to run ventilating fan; one 1 h. p. to St. John's Church, Reading, Pa.; one 15 h. p. to William Silverman, The Wire Buckle Suspender Co., Williamsport, Pa., to run shop; one 5 h. p. motor to John J. Tuomey, Jackson, Mich.; one 15 h. p. to W. W. Bullock, Wilmington, Del.; one 3 h. p. to D. P. Gosline, 32 Oliver st., Boston, Mass., ventilating fan; one 15 h. p. motor to Queen City Electric Light Co., Gadsden, Ala.; one 1 h. p. to Silvey Electric Co., Lima, O.; one 2 h. p. motor to Meyer, Singer & Co., Lycoming Pants Factory, Williamsport, Pa., to run sewing machines; one 4 h. p. to D. Coughlin, 5 Mill st., Lawrence, Mass., to run 28" saw; one 1 h. p. motor to Trinity Episcopal Church, west Fourth st., Williamsport, Pa., to run organ bellows; one 7 h. p. motor to Mercantile Printing Co., Wilmington, Del., to run presses; one 20 h. p. motor to Perry Woodworth, Smith building, Cincinnati, O.

THE COMING OF AGE OF AN ENGINE COMPANY.

The interesting fact that the New York Safety Steam Power Company, of 30 Cortland street, comes of age this year, has not received the attention it deserves in mechanical and engineering circles. The mere fact that a concern had withstood for twenty odd years the stress and strain of competition, in America, in one of the fields of hottest struggle and most rapid development, would of itself be cause for at least passing comment and congratulation. In the present instance there is to be borne in mind the further fact that the company, so far from resting upon its achievements, is in the full swing and brimming tide of activity and prosperity.

The explanation of such staying powers is to be looked for, of course, partly in the excellence of the product, and, to no small degree, in good business and technical management. Withregard to the engines themselves, of which some 50 types are now built and carried in stock, the records in the possession of Mr. E. T. Copeland, the general agent, show that 6,000 have been sold. These, averaged at 50 h. p.—the general run being now above that figure—would represent the magnificent total of 300,000 h. p. Some of the customers have bought the engines with an avidity that apparently nothing could satisfy, and one appears on the books as purchaser of no fewer than 62, up to February, 1889, since which time it has gone on buying as eagerly as ever. The big Cambria Iron Company, of Johnstown, Pa., had bought some 40 up to the time of the great flood. The engines in both instances are of the company's celebrated vertical type, ranging up to 30 h. p.

As is well-known, however, Mr. Copeland has of late years studied the developments of the electric lighting business very closely, and hence these figures are much more than paralleled by some of those furnished by that branch of industry. With one system alone, coming down no later than the early part of 1889, he had considerably over 100 engines in operation, many of large horse power; and the figures with other systems are in comparison and equal. Every one knows the exacting requirements of dynamo operation, in close regulation and smoothness of running, and it will be seen that these are squarely met when we state that a large proportion of the 50 engines put out by the factory, one week during this month—between 2 and 50 h. p.—were called for by electric light and power plants.

The development of electric lighting and power, and of the high speed automatic engine of to-day have gone on together, but Mr. Copeland considers that the point has about been reached when a fresh departure may be looked for, and when the work of engine building for electrical plants may soon be expected to lie along new lines. In some respects, he deems the more recent work to be purely experimental, and in others that the data as to the actual necessities is not yet all to hand. But so far as the work has gone, the New York Safety Steam Power Company has been prominent in it and actively engaged at the front; and it reaches its majority ripe in experience, rich in ideas, and ready for all that lies before in yet untried and even larger fields of usefulness.

THE MASSACHUSETTS ELECTRICAL ENGINEERING COMPANY.

The Massachusetts Electrical Engineering Company, formed a few months ago to do general electric engineering work, has been steadily increasing its business. Several tests have been made on street railroads, new dynamos, motors, telephone cables, etc., the results of which go to show the advantages derived by those interested from tests made by unprejudiced but competent engineers. In the line of constructive engineering, the company have been equally successful and busy, particularly in the direction of electric power transmission. On account of the large business which has so rapidly developed, the direction of their various interests has been further systematized by the formation of the following five departments: the Engineering, the Supply, the Testing, the Patent, and the Exporting Departments. The Engineering Department gives disinterested advice upon all electrical matters, designs and estimates upon electric lighting and power plants, obtaining bids for the same from the various electric companies. It also furnishes engineers to superintend construction or installation, its position toward its clients being similar to that of an architect towards his. The Supply Department manufactures and sells such electrical goods as from time to time are found necessary or advisable to place upon the market. It aims not to compete so much in price with other dealers as in trustworthiness. Having, as it does, the valuable assistance of the Testing Department, it can hardly fail of marked success in this direction. The Testing department does testing work of every description, calibration of instruments, etc., and furnishes, when desired, certificates of tests made on apparatus or devices. The Patent Department investigates and negotiates patents. The Exporting Department carries on a general engineering business with the West Indies, South America, etc. Mr. Charles A. Stone and Mr. Edwin S. Webster are the managers of the company, and Mr. Francis R. Hart the manager of the Supply and Exporting Departments. Their office and testing rooms are at 4, Post Office Square, Boston.

THE HALL CIRCUIT BREAKER.

MR. GEORGE L. HALL, of the Lowell, Mass., electric light station, has just designed an apparatus intended to prevent accidents due to the breaking of a wire on high tension circuits, by the latter coming in contact with metallic roofs or with persons and animals. According to the Lowell *Times*, the apparatus consists of two parallel steel flat bars or levers, broken in the middle and arranged with one piece of each over-lapping the other. These bars are fastened at each end to brackets by a lever joint. They are so insulated as to prevent any electrical connection between them and the whole machine is inserted into the circuit at the station near the dynamo. The current passes out from the dynamo through one of the bars over the circuit of lights and back through the second bar to the dynamo, completing the connection. Ordinarily, on account of the break in each bar, they would fall apart and cut the dynamo off from the wire and lights outside the station, but the first connection between the dynamo and the bar is made through a very powerful electro-magnet which acts when the current is complete and keeps the bars in place, the first half of each lapping under the second. It will be seen that in order to charge the electro-magnet and make it effective the circuit must be complete. The moment that a wire is broken at any place, the circuit is destroyed and the magnet, losing its powers, lets the bars fall apart and renders the entire line outside the levers harmless. The bar in falling starts a large electric bell ringing and calls the attention of the station to the break.

PROGRESS IN ENGINE BUILDING.

Electric lighting has probably had more influence on steam engine building in recent years than all other industries combined, and the experience already gained is making itself felt in various directions. After numerous experiments the Armington & Sims Engine Co. have arrived at the conclusion that the greatest economy in every direction can be gained from the double high pressure compound engine, and they propose to devote considerable attention to this type in the future. The merits of this engine combination are also being recognized by the managers of electric light and power stations. Thus, four of these engines of 250 h. p. each are now installed in the power station of the West End Street Railway Co., of Boston, Mass., and a contract has been entered into with the Boston Edison Co., to furnish 600 h. p. from their electric light station, which is also equipped with Armington & Sims' engines.

MORE ABOUT CONSOLIDATION.

With regard to the remarkable dispatch from Haverhill, referred to recently in our columns, the Lynn *Item* says very pithily:—"The *Item*, and Lynn stockholders in general, are fully satisfied with the Thomson-Houston management, and whatever may be done relative to the interests of that company will not effect such an ending as will discriminate between the large and small shareholders of the Thomson-Houston stock. Still another matter worthy of consideration is the fact that any important business in relation to the Thomson-Houston affairs will not from actual necessity be made known through any presumed or assumed news agency at Haverhill, Mass. In two particulars, at least, our readers may rest assured. First, that whatever the deal may be, the management of the Thomson-Houston Company do not deem it necessary to consult the general public or make of them confidants in any particular. Secondly, the management of the Lynn company will never enter into an agreement whereby the minority stockholders of Thomson-Houston will be deprived of any rights they now enjoy."

C. & C. FAN OUTFITS.

The C. & C. Electric Motor Co., 402–404 Greenwich street, have issued a neat little pamphlet on "Fan Outfits," a subject that becomes of special interest as the warm weather advances. These outfits have now been in the market for four years, with growing popularity; and the styles now illustrated are such as to meet the most varied wants. At the end of the pamphlet is given a list of some of the users of the apparatus. It is only a partial list, but gives a good idea of the range of work being done.

THE NATIONAL FEED WATER HEATER IN ELECTRIC LIGHTING AND POWER PLANTS.

The National Pipe Bending Company of New Haven, Conn., manufacturers of the National Feed Water Heater, report an active demand, having sold 35 heaters in February and 47 in March, including one 200 horse-power to Haddenfield Electric Light Company, New Jersey; one 300 horse-power to Consolidated Electric Light Company, Great Falls, N. H.; one 600 horse-power to Albany, N. Y.; one 200 horse-power to Westinghouse Electric Company, Bluff Point, N. Y.; one 150 horse-power to Citizens' Electric Light Company, Burlington, Vt.; one 200 horse-power for a Spanish Electric Company; one 200 horse-power to Newport, R. I.; one 150 horse-power to Spanish Electric Light Company, Puerto Principe, Cuba; one 100 horse-power Edison Electric Company, Martinsburgh, W. Va.; one 150 horse-power to Hyde Park Electric Company, Hyde Park, Mass.; one 150 horse-power to Electric Light Company, Jamaica, West Indies, and one 500 horse-power to Utica Electric Railway Company, Utica, N. Y.

KORTING GAS ENGINE CO.

The annual meeting of the stockholders of the Korting Gas Engine Co. was held on April 3, at the company's office, 74 Cortlandt street. The following officers were elected for the ensuing year: President, George W. Sillcox; Secretary, Maximilian E. Mora; Treasurer, Arthur Kitson; Assistant Treasurer, M. E. Mora. The business done during the past year was exceedingly satisfactory, and showed an increase of 100 per cent. over the amount done during the year preceding. Mr. A. Keating has things in charge at headquarters and reports that the company is full of orders and new business.

THE MAGNOLIA ANTI-FRICTION METAL COMPANY.

One of the most successful and pushing of the great soap manufacturers in England has made a great hit by his patronage of the fine arts, buying up and reproducing pictures and statuary that served in any way to illustrate the principle that cleanliness is next to godliness, and sometimes preferable. Our good friends, the Magnolia Anti-Friction Metal Company of 74 Cortlandt St., this city, bid fair to win like prominence in this country by their ingenious utilization of music and belles lettres. Their magnolia flower is familiar to everybody, but they recently "painted that lily" by bringing out the Magnolia waltz, with a beautiful title-page. This they have now in turn supplemented by a romance entitled "Luxilla," by George E. Miller, issued in neat brochure form with embossed cover. It can be had on application, or for 3 cents to cover postage. It is a fantastic prose poem, with not a few clever passages, suggesting now one of George Sand's best works, and again reminding the reader of Wilhelm Meister. We do not pretend to have the power to penetrate the mysteries hinted at, but there is some satisfaction in identifying such spiritual personages as Electro, Vapri, Dyni, and the like. The next thing we look for from the Magnolia Company is a thrilling melodrama, at Niblo's, where the plot turns on the ability of the Magnolia bearings in some huge marine engine to resist the evil work of a villain who seeks to drown in mid-Atlantic the heiress to untold wealth. We now file our application for a box.

NEW ENGLAND TRADE NOTES.

MR. DAVID CHALMERS, of the Empire City Electric Co., of New York, was in Boston, this week, looking up his many friends. The special purpose of his visit was to introduce in the east their new "Helmet Brand" insulated wires, which the Empire City company have recently commenced to manufacture.

MR. W. J. PILICY, has been appointed New England agent for the Card Electric Motor and Dynamo Co., of Cincinnati, O., and also for the Fidelity Carbon Manufacturing Co., of St. Louis. Mr. Pilicy has been connected with electric business for about 15 years, and is familiar with it in all its various phases.

THE GOULD PACKING CO., of Boston, are doing a large business supplying electric light and power companies with their patent packing for engines. The packing is made of rubber and canvas, thoroughly saturated in a special solution, and is cheap and clean to use, giving no trouble to the engineer. All engineers would do well to procure samples, to assure themselves of its good qualities.

THE WALWORTH MANUFACTURING COMPANY of Boston are in receipt of orders from the Union Depot Railway Company of St. Louis, for 21 heavy anchor poles, weighing about 1,350 pounds each, and about 100 ordinary poles.

MR. SAM. ELDER, well known in electrical circles in the East, is going to Pittsburgh in the interests of the Brush Electric Company and the Short Electric Railway Company. Mr. Elder will be associated in Pittsburgh with Mr. John E. Ridall, for years the manager of the Brush Electric Light Company, in Pittsburgh.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY.

The above company, Mr. Seely informs us, will remove on May 1, from its present quarters, to 24 Cortlandt street, in order to secure larger facilities for its business. It has been enjoying a run of large work, and has recently been furnishing the wiring of the new *World* building on Park Row.

WESTINGHOUSE CONTRACTS AND EXTENSIONS.

BROOKLINE, MASS., and Johnstown, N. Y., are both going in for long-distance electric lighting. The electric light companies at these respective places have just concluded contracts with the Westinghouse Electric Co. for special machinery for long-distance lighting. The Brookline plant is to have an apparatus of 900 lights capacity and Johnstown of 500 lights capacity.

THE OURAY, COL., ELECTRIC LIGHT CO., one of the oldest alternating current central station plants of electric lighting in the country, a few days ago contracted for an increase in its capacity. The Westinghouse Electric Co., is now occupied with putting up one of its 750 light machines, making the total capacity of the plant 1,500 lights.

FOR some months a 750 light alternate current incandescent machine of the Westinghouse manufacture has been in use at Sherman, Texas. The company operating the machine is evidently well pleased with its workings, for it has just placed with the Westinghouse company, an order for an additional machine of 750 lights capacity.

MOUNT MORRIS, N. Y., is not a very big town, but the people who dwell in it are to have the advantages of electric lighting. An order was recently placed with the Westinghouse Electric Co. for a 500 light outfit for Mt. Morris, and no time will be lost in the installation of the apparatus.

THE UNITED ELECTRIC LIGHT AND POWER CO., of Springfield, Mass., ordered a few days ago from the Westinghouse Electric Co., an increase of 3,000 incandescent lights capacity to its present plant. The United company has in use Westinghouse dynamos of a capacity of more than 5,000 lights, and with the addition of the late order will have a plant of very considerable size.

THE WESTINGHOUSE ELECTRIC CO. has just closed an order for a 750 light incandescent outfit to go to St. Thomas, Ont. The St. Thomas Gas Co. is the buyer. The plant is to be installed at once.

MARTIN'S FERRY, OHIO, is to use the new Westinghouse arc lighting system. An order has just been placed with the Westinghouse company for a 40 light machine.

THE UXBRIDGE & NORTHBRIDGE ELECTRIC CO., of Northbridge, Mass., which is using the Westinghouse incandescent system, has decided to embark in arc lighting, and with that end in view has placed an order for a Westinghouse arc light machine of 60 lights capacity to be shipped as soon as possible. Orders are coming in rapidly for the new arc lighting apparatus of the Westinghouse Electric Co., and satisfactory reports are received from those who have put the apparatus in use.

SUSQUEHANNA, N. Y., is soon to be a well lighted town. The residents of the place will have at their command the light supplied by the Westinghouse alternating current system, and the streets will be rendered safe by illumination derived from the arc lighting apparatus of the same make. The company which is to do the lighting starts out with a capacity of 750 lights incandescent and 80 lights arc.

THE WESTINGHOUSE arc lighting system has been adapted by the Evanston (Ill.) Electric Illuminating Co., which has for some time been employing the incandescent apparatus manufactured by the Westinghouse company. The arc light plant will have an initial capacity of 120 lights.

THE WESTINGHOUSE ELECTRIC CO. has an order from Joliet, Ill., for one of its new arc machines of 60 lights capacity. The order comes from the Joliet Electric Light Co. which is running an incandescent plant of the Westinghouse system.

.... THE dynamo-designer must get used to thinking of distances, not in inches, but in centimetres. There is no doubt that this is a great affliction, for he still uses the inch as his unit of measurement when making calculations of strength and stiffness. —*John Perry.*

.... DYNAMO building is now a small branch of mechanical engineering, but it is already infinitely further advanced than could have been expected in so short a time. A dynamo can be designed to give the desired output within one or two per cent.; yet though steam engines have been made commercially for about 10 times as long, no such results as this are possible with them.—*Industries.*

THE EDISON MACHINE WORKS.

The fourth annual banquet of the Edison Mutual Benefit Association was held at Schenectady on April 19, when some 350 men from the big machine works sat down together. The menu cards were finished in the form of an Edison dynamo, and with a tinted and bronzed fac-simile of a dynamo on the outer side. At the head table, in front of the stage, sat the officers and directors of the association, the invited guests, and the members of the orchestra. The officers, elected April 2, 1890, were: President, W. George Rothwell; vice-president, C. F. Hild; secretary, Ernest J. Bergren; treasurer, William Tanis. The directors, elected at the same time, were: Peter Weber, H. M. White, W. G. Shaible, H. Fitzgerald, Emil Kolben, C. Granneman, C. S. Moore, James Clark, Alfred Lundgren, M. Swart, John Waldron and C. Pink. The association is doing a good work.

WESTERN TRADE NOTES.

SHAY, STEPHENS & CO. are doing their usual large amount of business in their electrical glass specialities, notwithstanding that their prices on battery jars have been recently advanced somewhat, due to scarcity of material employed. The special glass insulator for inside work which this company manufacture largely is meeting with great success. It is claimed to be preferable to the ordinary porcelain insulators on account of its higher insulation and increased durability.

THE SPRAGUE ELECTRIC EQUIPMENT CO. have just closed a contract to build the new electric road at Elgin. This road will comprise 10 miles of track and operate 9 motor cars and quite a number of trailers. The Elgin company have recently purchased an Edison light plant, and propose to run the two businesses in co-operation. The Sprague company has recently started electric cars in Milwaukee on the Wells street line and also on the Twelfth street line, and within a few days will be running over the Grand avenue line. A very handsome marble switch-board has been installed in the station on which the various switches and measuring instruments are located.

MR. FOREE BAIN, who was selected as Consulting Electrical Engineer by the Minneapolis Street Railway Co., has just returned from a short trip to that city, where he went to confer about the new electric system.

THE ELECTRICAL SUPPLY CO. have recently received some very large consignments of the well-known Habirshaw rubber wires, and will carry a complete and extensive stock right along, enabling them to fill orders, no matter what their size, at very quick notice. Notwithstanding that they have but recently taken hold of these wires in the West, they have already closed some large contracts, and are beginning to receive numerous small orders from all parts of the country.

THE WESTERN ELECTRIC CO., have now completed the additional two stories which they have added to their enormous factory on Clinton street. They employ in the neighborhood of 1,100 hands right along, and the quantity of supplies of all kinds and specialties which they turn out daily is stupendous. Now that their building is completed, they propose to increase their magneto-bell, switch-board, wood-working and insulating departments, for which purpose their extra space will be employed. It is needless to say that they are busy all the time. Their Patterson cables are meeting with great success for underground work, carrying currents of very high tension successfully. The Chicago Arc Light and Power Co. are using large quantities of this cable for their underground circuits and continually making additions to the already large amount which they are employing.

THE STANDARD UNDERGROUND CABLE CO. have recently shipped 10 miles of their standard weatherproof wire to Utah, and are busily employed trying to catch up with their orders, which keep coming in all the time. They are going to put up new works to cover an area of four acres, situated at Wilmerding, in the vicinity of Pittsburgh, which will be pushed through without delay, thereby giving them greatly increased facilities to meet their rapidly growing trade. Amongst other orders they have just shipped 20,000 feet of telephone cable to Minneapolis.

MR. GEORGE CUTTER, 80 Adams street, Chicago, has returned from his trip East in first-rate health and spirits. While away he became interested in a new anti-induction telephone wire, by the employment of which the instrument is totally unaffected by any outside currents and altogether independent of single wire trolley or alternating systems. Circuits will be put up right away in the West under the most severe conditions that can possibly be brought to bear upon the test, and some interesting developments will no doubt be forthcoming. Mr. Cutter has also, it is said, purchased a large interest in the Simplex Electrical Co. He has also taken hold of a new electric water purifier, of which great things are expected, and for which certainly the field is large enough, so that, all told, Mr. Cutter seems to be one of the most hopeful men I have met for quite a while.

AN ENORMOUS ORDER FOR ROEBLING ELECTRIC WIRE AND CABLE.

With regard to the large order recently given to John A. Roebling's Sons Co. by the Minneapolis and St. Paul electric roads, Mr. George C. Bailey, the manager of the Chicago house, writes us that the original contract was for about 100 miles of lead encased cable and 100 miles of overhead conductor, as well as a large amount of bare copper wire and connectors, etc. This is said to be the largest contract that has ever been taken in this country or Europe for this line of goods. The deliveries are to begin early in May, and all is to be delivered by July 1. The order was placed through the Chicago branch of the concern.

PERKINS LAMP COMPANY.

The annual meeting of the Perkins Electric Lamp Company was held at the company's office on Pearl street, Hartford, last week. Every one of the thousand shares was represented. A dividend of ten per cent. was declared. It was voted to move the main office to Manchester as soon as suitable quarters could be obtained. The old board of directors was re-elected as follows: M. S. Chapman, J. J. Gates, W. G. Halm, W. B. Whiting and C. T. Welles. The directors re-elected the old board of officers, viz.: President, M. S. Chapman; vice-president, W. G. Halm; secretary, J. J. Gates; treasurer, C. T. Welles. It is said that the capacity will be doubled.

NEW ENGLAND TRADE NOTES.

Another Wire Factory.—It is reported that a lot has been purchased and another insulated wire factory, 45x90, one story high, to be run by electric power, is to be immediately put up on Water street, Plymouth, Mass.

Mr. W. E. Stowe is at present busy installing a Thomson-Houston isolated plant in the store of Messrs. C. F. Hovey & Co., and his friends are all congratulating him upon his ability to resume active work, after his long sickness. The plant consists of a 30-light arc dynamo, and a 200 incandescent dynamo, to be driven by a 45 h. p. McIntosh & Seymour engine.

The Robinson Radial Car Company will have running within the next few days on the tracks of the West End Company in Boston, their new large closed car, which will have a seating capacity for forty people. They are also busy preparing for the same company fourteen trucks for open summer cars, which will each have a seating capacity of 50.

The Brown Electric Protector Company are about to be organized, with headquarters at 54 Devonshire street, for the purpose of pushing the sale of the Brown electric protector, a well known successful device for protecting delicate instruments, such as telephones, time clocks, fire alarm apparatus, etc., from heavy currents, should the wires become crossed. Several prominent electrical and insurance men are interested in the company, who will lend their valuable influence in pushing the instrument, which has already had a very successful career of about 2½ years.

Mr. Paul D. Chase has just been appointed New England agent for the Daft Electric Light Co. of New York, and will hereafter push the Daft system of electric railway in New England. The Daft Co. have a double trolley track in operation in Meriden, Conn., and have just made a contract in Gloucester, Mass., for a double trolley system, consisting of five miles of track and three cars at present. All the details of the system are now perfected, and Mr. Chase claims that they have effectually got over all the trouble of frogs and switches which might be expected from a double trolley system. Mr. Child, of the Daft Co., has gone to Gloucester to arrange details and lay out the pole line.

The Wright Electrical Engineering Co. recently completed the rewiring of the well-known steam yacht "Sagamore," the property of Mr. W. A. Slater, of Norwich, Conn. A new set of accumulators, 54 in all, were put in, with water-tight and acid-tight hard rubber cells, giving a potential of 110 volts, and yielding current enough for 100 16 c. p. lamps. Porcelain switches, and slate and porcelain cut-outs have been used throughout. The switch-board was made by a ship carpenter, and is of black walnut. The dynamo, of the Edison type, and accumulators, are run at the same time, and the accumulators are run alone in the evening when the steam engine is stopped. Automatic charging cut-outs have been used, so as to prevent the batteries from charging back into the dynamo. Edison fittings are used, and the general appearance is very handsome. The accumulators were specially made by the Accumulator company, of New York, so that they could be tipped to an angle of 30 degrees without spilling. A complete set of Weston ammeters and voltmeters has been fitted, and everything done to make the plant thoroughly reliable and efficient.

Mr. H. E. Duncan, of the American Waltham Watch Co., who has recently returned from an extensive and successful business trip on the Pacific slope, entertained a few gentlemen this week, interested in electrical affairs, by conducting them through the mazes of the Waltham Watch Co.'s factory at Waltham, Mass. The party consisted of Mr. A. B. Griggs, a gentleman well known in electrical circles, but more recently known as the promoter of the "Teleport," Mr. Stanton Day, Mr. W. E. Stowe and the writer. Commencing with the machine shop in which about $2,000 is spent every week in perfecting machinery for the manufacture of the watches, Mr. Duncan took the party over the whole establishment, winding up with a visit to the *sanctum sanctorum* where the most delicate adjustment of the high grade instruments is made. To attempt a description of the factory in these brief notes would be entirely futile, but it may be said that the machines for the manufacture of the 460 various parts of which a watch is composed, are simply wonders of accuracy, and being chiefly automatic are a source of intense interest, as showing the perfection of mechanical art. The factory at present is extremely busy, some 2,700 employees being engaged in producing about 1,700 watches every day, and more space is now being added. Mr. Duncan was sincerely thanked for providing a most enjoyable and interesting afternoon.

WESTERN TRADE NOTES.

Mr. E. D. Floyd, so well-known in the west as purchasing agent of the Thomson-Houston Co. has resigned his position here and goes to Boston to fill a similar position with the parent company there.

Mr. G. A. Kohler, agent for the Eddy Electric Mfg. Co., of Manchester, Conn., has opened an office in the Rookery, where he will carry on business selling this well-known motor, which has met with a wide adoption and use by reason of its many excellent qualities. Mr. M. E. Baird, of the Eddy Co., was in town this week.

Wm. Baragwanath & Sons are very busy manufacturing their feed water heaters, and have recently received quite a number of fine orders, one 2,000 h. p., one 600 h. p., one 400 h. p., one 1,000 h. p., and two 800 h. p., are among the list. These heaters have given great satisfaction wherever used, and their numbers are rapidly increasing.

The Rice & Whitacre Mfg. Co. are doing a large business in their Stationary Marine & Hoisting Engines. They have two engines of 90 h. p. each, furnishing power for the electric lights in the Terminal station of the West side cable plant. They make a speciality of small engines, boilers, and electric launch work, and their "Kriebel" engines are receiving much commendation for their general merits and efficiency.

The Central Electric Co.—Among their numerous recent orders may be noted the sale of a 14 conductor Okonite telephone cable for aerial work. They report that the demand for high class testing instruments is increasing very rapidly, and that their Weston voltmeters and ammeters are in large demand. These instruments have acquired a reputation throughout the country for their extreme sensitiveness and accuracy, while at the same time embracing numerous features of convenience and durability which have too often been lacking in instruments of great delicacy. The location of the company on Franklin St. is becoming quite an electrical centre. The Central Union Telephone Co. have recently moved in right back of their building, and already in the near vicinity are situated the Chicago Telephone Co., the Chicago Arc Light and Power Co., and Foree Bain.

Mr. Gilbert Wilkes has resigned from the Navy and joined the United Edison Manufacturing Co. at 65 Fifth avenue, New York.

The Edison General and Sprague Co.s are now being represented in Chicago by Mr. S. Dana Greene and Mr. C. A. Benton, both of whom have gone on recently to take charge of affairs there.

Knight Bros., the well known patent solicitors and experts, will remove on May 1 from 234 Broadway to Temple Court, 121 Nassau street. The firm is composed of O. Knight, H. Knight, and H. E. Knight.

The Fort Wayne Electric Co. have bought the Waterhouse Company, of Baltimore, and have secured an option on the International Co. of the same city, which is operating incandescent lights on the Heisler system. Options on several other electrical enterprises in Baltimore have been secured by the Fort Wayne company.

Pan-Electric.—A special dispatch from Washington of April 21 says: "In the court in General Term to-day, a decision was announced in the celebrated Pan-Electric case, otherwise the case of J. Harris Rogers against ex-Attorney General Garland, General Joseph E. Johnston, Isham G. Harris, John D. C. Atkins, and Casey Young. Judge Cox delivered the opinion of the Court. The case has been in the courts since the Summer of 1886, and was brought for dissolution of partnership, an accounting, etc. The bill is dismissed, each party to pay his own costs."

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada.	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, MAY 7, 1890. No. 105

No one can do harm but only good, who works with an earnest and truthful spirit.—Faraday.

MUNICIPAL AGGRESSION UPON PRIVATE PROPERTY.

THE recent decision by the Supreme Court of Ohio, in the case of the State *ex rel.* Hamilton Gas and Coke Co. *vs.* City of Hamilton, of which some account is given in the legal department of our present issue, affords an instance of the apparently growing tendency of courts in this country to decide adversely to the interests of private property where conflict with municipal, state or national interests appears to arise. In this case no electric interests are directly involved; but the result may have a very important influence upon the welfare of electric lighting companies which may similarly find themselves face to face with threatened confiscation of their property.

The Hamilton Gas and Coke Company had invested in gas works, and supplied the city and its citizens with light since 1855, under the general incorporation act of 1852, and under a municipal franchise of the city of Hamilton, when in 1888, the city, by ordinance, ratified by a vote of its electors, went into the gas lighting business. The municipal works, since their completion in 1889, have furnished the city lighting, and may at any time undertake private lighting; thus seriously impairing and threatening to destroy the value of the Gas and Coke Company's property. The suit instituted by the company for the protection of its property and business has been determined against it by the court, which rules virtually that a gas company, established and conducted under a municipal franchise, can maintain no legal protection against competition by the municipality which has granted its franchise, even when such competition may practically confiscate the property of the company.

We commend to our readers a perusal of the extenive extracts from the energetic dissenting opinion by Judge Spear, printed in our legal columns.

The convenience and rights of the municipality and of the citizens, as against the gas company, were duly protected by provisions in the general law and its amendments, obliging the company to furnish all required service and to submit to municipal regulation of prices. There was no allegation that the company had failed in any lawful requirement. Judge Spear says:

> Under this law, so long as a company complied with every lawful requirement to the public and to private consumers, the public object of the statute was accomplished, and, if the construction I contend for be correct, the right of the company to furnish gas to the city and to private consumers therein remained unimpaired, and the city had no power to interfere with the company's chartered rights by entering into competition with the company while carrying out the purpose of its organization. It is not pretended that this company has, in any respect, failed in tne performance of any lawful requirement.
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> In effect the statute gave to this company the exclusive right, so long as it complied with every requirement of law, to supply gas to the city of Hamilton and its inhabitants.
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> * * * * * * * * *
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> The construction of the statute claimed by the city is not reasonable. It shocks the moral sense. * * * *
>
> In this case the state held out the inducement to all citizens to organize for the purpose of supplying a public want of municipal communities. The incorporators of the Hamilton Gas Light Co. accepted the state's proposition as regards the city of Hamilton. No other citizens did accept it. The company then went forward, and, in all respects, performed the duty, complied with the law as it then was, and with all amendments as to its proper regulation which have since been enacted. With what grace can the state now say to it, "You must withdraw, and leave to another agency the performance of the duty we intrusted to you, and lose the value of the property you have acquired in performing that duty, —property which, from its nature, can neither be removed nor profitably applied to any other purpose?"

This case illustrates the unsatisfactory situation of gas and electric lighting companies, depending as they do upon "the caprice of city councils or the impulsive vote of the people." There results from this state of affairs hesitation of capital to undertake enterprises of this kind; necessity of large earnings to compensate for risks; unequal prices in different cities, and consequent dissatisfaction and distrust on the part of the public; attempts on the part of lighting companies to make their position more secure, which elicit opposition from the public and accusations of unfair dealing, and generally a state of warfare between these public service companies and the communities in which they operate.

It is not necessary to point out the advantages to all concerned—and everyone is concerned—in a different state of affairs; in having investments in this class of enterprises made secure, and thus enabling capital to be obtained readily for reasonable returns; in having prices differ only as recognized controlling conditions differ; and in removing the asperity and friction between the public and the companies which serve them.

It would seem that a feasible plan for accomplishing this is to secure the appointment of a commission in each state, similar to the one now giving satisfactory results in Massachusetts, with authority to prevent competition either on the part of municipalities or on the part of other private corporations, and at the same time giving the public protection by regulating prices.

AMERICAN ELECTRICAL UNITS.

THE additions made to electrical nomenclature by the naming of various units have been the necessary outcome of the desire to avoid periphrasis and to fix the units as a permanent part of the science. It was but proper that in the selection of their names the illustrious men to whom the science of electricity is so much indebted should be commemorated, and no more fitting monument could be devised to that end. Up to the present time such units have been derived exclusively from the names of European scientists, and hence not without cause there has arisen on this side a desire to have some of our own illustrious men of science recognized in a similar manner. The American Metrological Society has inaugurated a movement with this object in view, and will, we are sure, receive the hearty co-operation of all the societies as well as the individuals interested in electrical matters. As Mr. F. B. Crocker points out on another page, the names of Franklin and Henry are eminently adapted for the naming of units now constantly employed and which are of increasing importance. Though probably subject to the action of an Electrical Congress for final acceptance, these terms might be embodied at once as part of electrical nomenclature so as to make their use familiar as soon as possible. Such was the course pursued in relation to the term "watt," which was in current use several years before being officially adopted as the unit of electrical power. We shall lend our aid to any movement looking to the proper recognition of eminent American electricians, and trust that the prominent electrical bodies will take up the subject in earnest. It deserves mention in passing, that the suggestion of the "henry" came from Dr. Pupin, of the Columbia College Electrical Department.

UTILIZING NIAGARA.

Now that the plan of utilizing the the water power of the Niagara Falls is to be put into practical execution, in a local distribution of power to begin with, it will not be long before the electrical engineer will be called upon to transmit a considerable portion of it to districts several miles away. The all-important question, after the kind of current to be employed—whether continuous or alternating—is settled, is, of course, the potential to be adopted, which involves the size of the conductors. It is fair to assume that under whatever system of transmission adopted, whether alternating or continuous, series or parallel circuit, a reduction of pressure from the main to the distributing lines will have to be effected, so that the question of insulation of the main line alone will need serious consideration. One of the plans already suggested is to lay a cable from the Falls to Buffalo on the bottom of the Niagara River. While such a plan is undoubtedly feasible, it seems proper to inquire if the ordinary overhead air-insulated conductor would not fulfill all the conditions of safety and economy and present other advantages over the submerged or buried conductor. With proper construction and inspection and the application of well-known devices, a bare copper wire suspended overhead could be made reasonably safe even with a very high potential and, its dangerous character being known, it would be avoided, as much as the railroad track is, as a promenade. The cheapness of the insulation will be a large factor in determining the position of the line. With the high potential to be employed, any insulating material other than air, and the protecting armor, would probably cost as much as, if not more than, the copper itself and would thus figure as a large item of the cost. As Sir Wm. Thomson recently pointed out there can be not the slightest objection raised to the adoption of bare wires carrying high potentials, outside of populated district,s and the many advantages of this method of construction are too apparent to require pointing out. Long distance power transmission in such districts will, we believe, be largely done with bare conductors, and, in our opinion, with perfect propriety.

Air in Incandescent Lamps.

THE substitution of the carbon filament for the metallic made the employment of a vacuum within the enclosing globe a necessity in order to prevent the combustion of the filament. But another and important function of the vacuum, which is often lost sight of, is its effect on the efficiency or power consumed by the lamp for a given illumination. This is forcibly pointed out in the short paper appearing in another column which shows that two lamps with identical filaments, but unequally exhausted of air, may differ several hundred per cent. in efficiency. These experiments may also serve as reminders and warnings to those who, from time to time, propose the substitution of some inert gas for the vacuum in incandescent lamps, unmindful of the fact that the vacuum plays a double role.

Specific Resistance of Metals.

IN this issue we bring to a close a very interesting and exhaustive essay by Mr. Geo. B. Prescott, Jr., on a subject of considerable importance. Nearly all electrical calculations involve the resistance of metals, and the conflicting conditions of "standard" tables have long been a subject of comment and complaint. That the experiments of Matthiessen upon which such tables are generally based, need revision is apparent when modern methods of manufacture can produce specimens of copper, for instance, showing several per cent. increase of conductivity over that obtained and adopted, by Matthiessen. Again, the discrepancies to be found in tables derived apparently from the same authorities have also given rise to confusion, and Mr. Prescott shows in what manner the divergences can be accounted for. As suggested by Mr. Prescott, who has long made the matter a special study, the time has certainly arrived when a revision of this important standard should be undertaken with the refined materials and apparatus which are now at our command.

Julien Storage Battery Interests.

WE are informed, upon the authority of the president of the Julien Electric Company, that we were premature in including the Julien interests among those consolidated in the newly organized United Electric Traction Co. noticed in our editorial columns last week. Mr. Bracken informs us that his companies have not been absorbed in the United Electric Traction Company, whatever current reports there may be to the contrary.

AMERICAN ELECTRICAL UNITS.

BY FRANCIS B. CROCKER.

THE suggestion has often been made that one of the practical electrical units, which it has been the custom to name after some eminent electrical scientist, should be given an American name, but as yet none but foreign names have been adopted. If the opportunity passes and no American monument is erected in the electrical Temple of Fame, it will be a reproach to the patriotism of our electrical engineers; it will be a very undeserved slight to the great contributions to electrical science made by Americans, and will not truly represent the greatly advanced state of electrical science and industry in this country.

To accomplish anything in this direction requires positive and concerted action on the part of the various societies interested in the matter. With this object in view I attended recently, as the authorized representative of the American Institute of Electrical Engineers, the meeting of the American Metrological Society, held at Washington, April 21, 1890. This latter society interests itself with units and standards generally, and has done some very excellent work during the last ten years in connection with the introduction of standard time, the metric system, etc.

At this meeting the following resolutions, introduced by Dr. T. C. Mendenhall, were unanimously passed:

> *Whereas*, It has been generally admitted among scientific men that the nomenclature of electrical units of measure should perpetuate the names of early electricians who have contributed most to the advance of electrical science; and
>
> *Whereas*, In the names thus far adopted, the eminent services of Americans have not been recognized; therefore,
>
> *Resolved*, That, in the opinion of the American Metrological Society, a just distribution of the honor thus bestowed, demands a recognition of the splendid contributions of one or both of America's great electricians, Benjamin Franklin and Joséph Henry, and that the society will gladly co-operate with the numerous organizations of electricians in the country, in an earnest effort to secure such action.

The question as to what particular unit should be selected was not specially considered at this meeting, as it was thought that this matter should properly be left to the electrical societies to decide.

In this connection I would like to call attention to the peculiar fitness of the name of Henry, for the unit of self induction, which name has been suggested to me by Dr. Michael Pupin. It was he who discovered self induction in 1832. Yet in spite of this fact the last Paris Electrical Congress (1889) ignored Henry's actual right to have the unit given his name, and American claims in general, and called the practical unit of the coefficient of induction, the "quadrant."

But this name is not at all satisfactory since it already has another significance which completely overshadows the electrical meaning. It is well enough to use this as the *value* of the practical unit, and say that it is numerically equal to the earth's quadrant expressed in centimetres ($1,000,000,000 = 10^9$); but it needs a *name* besides, and since Henry was the first and greatest investigator of self induction phenomena, nothing could be more appropriate than to give it his name.

The only objection to this is that the name of Franklin should naturally take precedence; but this can be overcome by naming another unit after him. The unit of specific inductive capacity, for example. It would be an improvement on the present clumsy expression, and although Franklin knew nothing of inductive capacity, he knew fully as much as Watt knew of watts, or Volta of volts. Moreover, he was the true founder of the modern theory of electricity developed by Faraday, Maxwell, Hertz and others, in which the dielectric plays such an important part.

There are other electrical units to which names will probably be given before long, for example, a unit of intensity of magnetic field which might be 1,000 or 10,000 c. g. s. lines of force per square centimetre, a unit of magnetic permeability or conductivity, and, perhaps several others.

It may be said by some that we do not want any more units, and, therefore, no names are needed for them; the fact is, however, that one or more electrical units are sure to be named and used in the near future, and, moreover, the necessities of more extensive electrical work demand them. When we have to use the expression "an intensity of magnetic field of 10,000 lines of force per square centimetre" very often, we will be very glad to substitute an expression like "one Franklin."

The best way to actually accomplish the fixing of an American name upon some electrical unit would seem to be for the American Institute of Electrical Engineers to take suitable action at the coming annual meeting in Boston this month, and the co-operation of local electrical societies, as well as of influential individuals, should also be secured. If in this way the movement is well started before the next Electrical Congress, the name, or names, will probably be adopted. There is another matter coming directly under the title of this article which needs and deserves attention from American electrical engineers. It is the fact that the United States Government should possess a collection of the electrical standards of the highest attainable accuracy, with means for comparison and verification, and these should be deposited at Washington in charge of a competent officer. Fortunately, the Superintendent of the Coast Survey, Dr. Mendenhall, who is by custom and appointment the custodian of all the United States Standards of weight and measure (yard, pound, metre, kilogram, etc.,) is very much in favor of the plan, and since he has great familiarity with, and takes great interest in, electrical matters, he is eminently well qualified to have charge of the electrical standards also.

Apparently the only way to carry out this idea, is to present to Congress a petition signed by the officers of the principal electrical societies and companies, asking that, say $10,000 be appropriated for this purpose. It would not be a large sum for the government to expend for the advancement of electrical science in this country, considering the vast importance of electrical work in every State in the Union.

If this appropriation were passed it would make it possible for anyone to send standards to Washington for official verification in the same way that weights and measures are now verified for a merely nominal charge.

The possession of the electrical standards by the government would pave the way and probably bring about the legalization of the electrical units by Congress, which is the last of the three important American electrical unit matters which now present themselves to the electrical engineers of this country for their attention and action.

ON A NEW SYSTEM OF ACCUMULATORS.

BY CHARLES POLLAK.

IN my researches on the accumulators of the Planté type it has been my aim to give them a large storage capacity in as short a time as possible. To that end I cover the plates with spongy lead obtained by the electrolytic method. In order to obtain the perfect adherence between the spongy lead and the surface of the plate, the latter is worked in such a manner as to present the appearance of a short hair brush which is obtained by means of a special laminator. These points are 2 mm. high and 1 mm. at their base. The interstices between the points are 1 mm. across. The plate after having been washed in order to remove the fatty matter, is covered with a paste composed of sulphate of lead mixed with salt water and immersed in salt water between two plates of zinc. The reduced plates present a uniform, gray appearance. The adherence is perfect between the spongy lead, the surface of the plates and the points.

After having soldered them the formation of the accumulator is proceeded with, which is effected by passing the current in the same direction for 50 hours. The negative plates have a grayish aspect; the positives are a dark brown. After the formation, the adherence of the active matter (spongy lead and bi-oxide of lead) is so great that one is unable to distinguish the boundary between the plate and the superposed layer. An accumulator composed of nine plates of which four are positive and five negative, and having a total weight with the connecting strips of 11.2 kilograms, after 45 hours formation with a current of 16 amperes gave the following current during discharge :—

Hours.	Amperes.	Volts.
12 M.	18	2.12
1	“	2.08
2	“	2.
3	“	2.
4	“	2.
5	“	1.9
5.18	“	1.8

Total, 95.4 ampere-hours of useful work.

The resistances through which the discharge took place were so regulated that the current strength remained the same throughout. The same accumulator, re-charged with a current of 16 amperes for 7 hours, gave the following on discharge :—

Hours.	Amperes.	Volts.
12 M.	17	2.2
1	17	2.
2	17	2.
3	17	2.
4	17	2.
5	17	1.95
5.30	16.5	1.92
5.45	16.4	1.87
6.40	16	1.8

The efficiency was therefore 91.384 per cent.; the capacity is 9.133 ampere-hours per kilogram of lead. It will be further seen from these two tables that the E. M. F. of the accumulators varies very little during the discharge but declines sharply toward the end.

The object has been to obtain in a small volume and with light weight a current of high E. M. F. which should be able to serve the particular requirements of a portable electric light. There has been constructed to that end a small battery of accumulators which I call a multiple accumulator. This is composed of plates of which each is positive on one side and negative on the other. The plates are bordered by rubber bands and separated by ebonite plates. The whole is perfectly water-tight.

THE EFFECT OF THE ELECTRIC CURRENT UPON FRICTION BETWEEN METALLIC SURFACES.[1]

BY LUCIEN I. BLAKE, PROF. OF PHYSICS, STATE UNIVERSITY OF KANSAS.

THERE has appeared from time to time in technical magazines and in newspapers the statement that an electric current passing through the surfaces of contact of a wheel and a rail upon which it ran, would decrease the tractive power by increasing the friction between the wheel and the rail. It has even been stated that 30 per cent. increase of traction could thus be produced with a current of 30 amperes. The importance of this fact to electric railways is evident.

With a view of determining the general relations between the strength of a current and the co-efficient of friction between metallic surfaces, a series of experiments was begun in September, 1889, in the physical laboratory of the State University. These experiments were carefully carried out by Mr. E. W. Caldwell, student in the electrical engineering course. The somewhat vague statements of the magazines were taken as authority for the fact of increased traction by the electric current.

The following four independent methods of experiment were devised :—

1. A column of mercury was made to flow between two platinum surfaces, each one inch square, each nearly parallel to the line of flow, and so arranged that a current could be sent, at will, from one platinum surface through the flowing mercury column to the other platinum surface. The accompanying illustration, Fig. 1, shows the general arrangement of the experiments, in which A and B are the platinum plates.

The time of flow of a given amount of mercury, with, and without, current, would serve as a method of determining the effect of the current upon the coefficient of friction of mercury and platinum.

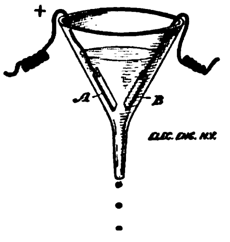

FIG. 1.

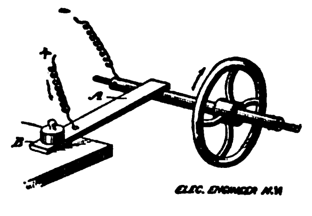

FIG. 2.

Two pounds of mercury were allowed to flow, and the time of flow without current was 29 seconds. A current of three volts, and varying from 0 to 1 ampere, was then sent from plate A to plate B through the mercury between them. No difference in time of flow was indicated. Mercury was selected, as no electrolytic action could take place at the surfaces of the platinum electrodes.

2. In the second method there was employed a steel spindle half inch in diameter, with a small fly-wheel 2½ inches in diameter rigidly attached to it. The arrangement is shown in Fig. 2. A small steel bar, four inches long, rested near one end upon the spindle at A. The other end rested upon a smooth stationary surface. The spindle was made to revolve at a uniform rate of speed. The friction between spindle and bar tended to roll the bar over the spindle; but by applying suitable small weights upon the bar at the end B, resting upon the smooth surface, the sliding friction at B was made to delicately balance the friction between bar and spindle at A, and the bar remained at rest upon the revolving spindle. A current of electricity was now sent through the contact of bar and spindle at A. No change in friction between bar and spindle could be detected.

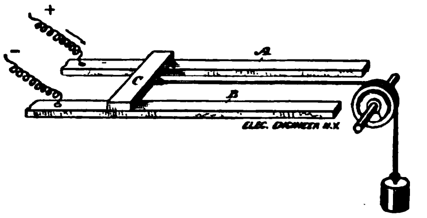

FIG. 3.

3. A third method was as follows: A metal bristle was soldered to the centre of the diaphragm of a Bell telephone, and projected a couple of inches out from its centre. The telephone was then so placed that the bristle rested across a rapidly revolving spindle, half inch in diameter. The friction of the bristle upon the spindle produced in the telephone a musical sound of definite pitch. A current of electricity was now sent through the contact between bristle and spindle. Had the friction been altered in any way the tone in the telephone would have been affected No change in tone was produced.

4. Finally, for a fourth method, an experiment with sliding friction was tried. Two highly polished brass ways, A and B, Fig. 3, about four feet long, were placed horizontal and parallel about three inches apart. A cross-piece of

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[1] Paper read before the Kansas Academy of Science, Wichita, Kans.

brass, c, rested with its ends upon the strips. A cord attached to the centre of the cross-strip passed over a pulley and had suitable weights attached, just sufficient to so slightly overcome the friction of the strip upon the bars as to produce and maintain uniform motion of the strip to the ends of the bars. The surface of contact between strip and bars was made to vary in repetitions of the experiments from 1½ to 3 square inches. A dynamo current of 10 amperes was now sent through the surfaces of contact by connecting one end of each bar to one dynamo terminal. The friction was unchanged. Uniform motion was still maintained without altering the weights.

It should be noticed that the currents employed were not sufficient to produce heating at the surfaces of contact. Such heating would doubtless produce an increase of the coefficient of friction.

The four wholly independent methods described above would seem to justify the conclusion that the friction of rolling or sliding contacts is not affected by the electric current passing through the surfaces of contact, provided the currents are not strong enough to produce sensible heating effects.

Whether such heating effects occur between wheel and rail in electric railways, when transit is rapid, may well be called in question.

THE WIRT LIGHTNING ARRESTER.

During the time that the telegraph constituted practically the only industry requiring the transmission of current over conductors exposed to the effect of lightning discharges, a comparatively simple device was adequate to protect the instruments from destruction. With the introduction of electric lighting circuits carrying comparatively heavy currents under high pressure, it was soon found that the old and simple forms did not answer the requirements, as the currents from the generating machine followed the stroke of lightning and maintained an arc at the arrester, thus endangering the machine and other apparatus, while at the same time causing the destruction of the arrester.

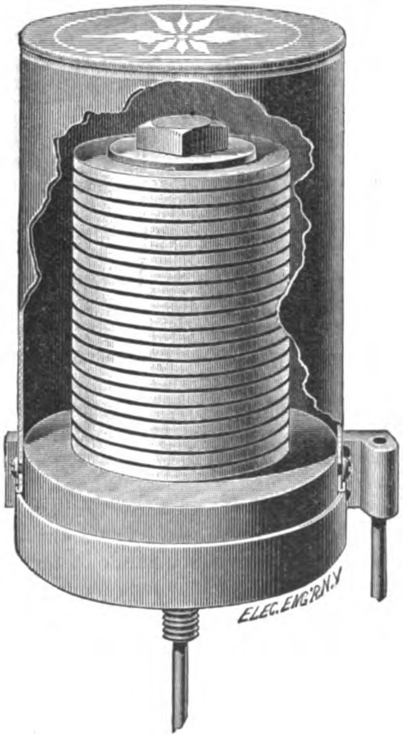


Fig. 1.—The Wirt Lightning Arrester.

Devices to overcome this difficulty were therefore invented, and have come into considerable use, and we desire to draw the attention of our readers to the latest of these, the invention of Mr. C. Wirt, which claims our attention on account of its originality and simplicity.

The object had in mind by the inventor was to provide an effective lightning arrester which should not have a single moving part, but which should prevent the maintenance of an arc by the cooling effect of a large mass of metal with numerous small breaks.

This has been accomplished by the construction illustrated in the accompanying engraving, Fig. 1, which shows the arrester in perspective in half its true size, with the cover broken away, so as to expose the interior. The section of the apparatus, illustrated in Fig. 2, gives a clear view of its parts. As will be seen, it consists of a series of metallic discs A insulated by mica washers B, all of which are mounted on a central bolt C. The bolt, besides holding the discs together, connects the top disc to the line through the leading wire attached to the screw end. The insulating tube D and the insulator E serve to separate the line connection from the ground-wire, which is attached to the base F.

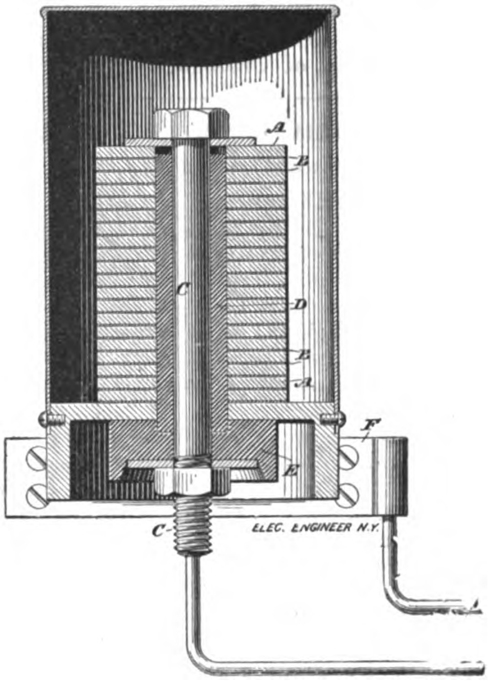


Fig. 2.—The Wirt Lightning Arrester.

It will be seen that by properly covering the terminal end of the bolt C, there will be no conducting parts exposed. In some situations this is an important feature of safety. The breaks between the discs are only about .002 inch in width; thus the aggregate distance to be bridged by the lightning spark is less than the single break generally in vogue.

The principle is a very beautiful one, and its effectiveness is best shown by starting an arc from a high tension dynamo over the surface of the arrester in any convenient manner. This cannot be done in the ordinary way with an induction spark, but actual experiments have shown that a current which will maintain an arc four inches long in the air will not hold an instant when divided by the breaks of the arrester, although the aggregate length of all the breaks will not exceed 1-20 of an inch.

The arrester illustrated is designed for indoor or outdoor use on all classes of circuits, and wherever protection is called for. As it needs no fuse, no inspection, and is weatherproof, it is especially suited for use outdoors. The difficulty of getting good service out of an arrester on poles, has led to dependence being placed on arresters placed in the station. There is no doubt that lightning should be kept as far as possible away from dynamos, no matter how well they may be supplied with protecting devices, and the arrester just described can be employed in the situation mentioned. Its construction also adapts it for use on electric cars, the motors of which are especially liable to destructive lightning charges. It will be noted that the construction adopted also obviates all electro-magnetic coils or solenoids which might offer a resistance to the discharge on account of their self-inductive action. It is claimed that while affording the readiest possible path to earth for all static charges, it is impossible for the dynamo current to pass when the arrester is properly designed for the tension of the circuit it is to be used with. The manufacture of the Wirt arrester has been undertaken by the Electrical Supply Co., of Chicago.

ANOTHER CRITICISM OF "MUNICIPAL LIGHTING."

BY HUNTINGTON LEE.

In The Electrical Engineer of April 9, on page 215, there appears an article by Mr. Rosewater on the cost of electric lighting, purporting to show that it is much cheaper for municipalities to operate their own electric light plants than to contract for them from a corporation. In the following issue on page 234 there appears a well-put protest by Mr. M. J. Francisco. I think that possibly a few more facts will be of interest, however, so I intrude this on your space.

Particular stress seems to be laid on the fact that Ypsilanti, Mich., is able to run its own plant every night at a rate of $23.61. A quotation from Mr. Fred. H. Whipple's able book on "Municipal Lighting," bearing the date of 1889 (which has an enviable reputation for accuracy) rather differs from this. He says: "In 1887 Ypsilanti, Mich., purchased an Indianapolis Jenney plant of 60 arc lights, paying $10,800. This did not include building, setting machinery, etc.; since then 20 lights have been added and, other changes made, bringing the cost up to $26,000. The lights burn an average of 18 nights a month till midnight, and with an independent steam station cost $40 per light; with added interest, etc., the cost is $72." I notice a few more errors in Mr. Rosewater's figures in regard to cities operating their own plants. Below I give you a correct table showing the lights and cost, in these cities:

Aurora, Ill............	80 lights..........	$95 per year.
Bay City, Mich........	182 "	82 "
Dunkirk, N. Y.........	56 "	62 "
Easton, Pa............	81 "	139 "
Grand Ledge, Mich....	34 "	79 "
Hannibal, Mo........	95 "	100 "
Huntington, Ind......	51 "	75 "
Lewiston, Me......	100 "	39 "
Little Rock, Ark.	100 "	96 "
Madison, Ind...	85 "	100 "
Martinsville, Ind......	31 "	24.19 "
Plainsville, O.........	65 "	62 "
Paris, Ill..............	56 "	55 "
Topeka, Kas..........	180 "	109 "
Ypsilanti, Mich.......	80 "	72 "

Mr. Rosewater says: "Boston pays annually the enormous sum of $180 per light, while the greatest cost under public control is $100, paid by Easton, Pa." Permit me to give you a few more figures:

Alameda, Cal., 120 lights, $155; Fairfield, Ia., 6 lights, $270 per lamp; Victoria City, 15 lights, $515 (4,000 c. p.).

The replies that the authorities of Ypsilanti, Mich., recently sent in answer to the following questions may be of interest:

Q. 1. With your experience are you in favor of cities doing their own lighting? *Answer.* No.

Q. 2. Why? *A.* Political preferences and frequent changes of management are too expensive. Incompetent engineers, linemen and trimmers kept in place by a committee for political or other purposes; poor carbons, lack of attention generally, grounding of wires, breaking of globes, infringement of patents, constant repairs, etc., make this system expensive and unknown amount till the year expires. The wear and tear is immense, all kinds of complaints, and no responsible head is the rule. On the contract plan for light, you pay for what you get only, and know what to provide for in the estimate for tax levy.

Q. 3. If your city had the work to do over again, do you think they would do the same? *A.* No.

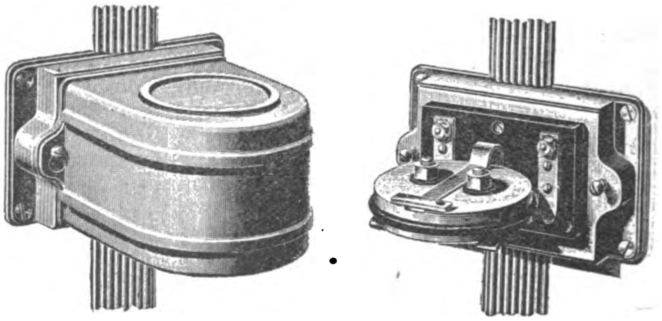
Q. 4. Has the municipal operation of your plant met all expectations and requirements? *A.* No.

I hesitate to make these corrections when the original article was written by such a well-known authority as Mr. Rosewater, of Johns Hopkins University, but it is only too apparent that municipal ownership of lighting plants is not the "rosy" side of the question after all.

THE CARDEW EARTHING DEVICE.

The accompanying engravings represent the latest pattern of the Cardew earthing device as modified by Messrs. Drake & Gorham, and adopted by the London Electric Supply Corporation. The action of the device is to connect the secondary circuit to earth automatically whenever a dangerous difference of potential is established between the lamp circuit and earth. This result is obtained by interposing some medium which will be of infinite resistance until a dangerous difference of potential exists, when a free passage for the leakage current is provided.

In the device illustrated the static arrangement is adopted, as it is found to give the best results. It consists of two brass plates placed near, but insulated from, each other. Between these lies a thin foil of aluminium, which is retained in position by ebonite pegs, one plate being connected to earth and the other to the secondary circuit. A flat projection is formed on the upper plate over one end of the foil, so that as soon as a difference of 400 volts is established, one end of the foil lifts by static attraction, and a metallic contact is made between the two plates. If there is a serious leak between the primary and secondary, and if the primary is also completely earthed elsewhere, the primary fuses in one or both of the houses in which the leaks occur are blown. These fuses will go with a current too small to cause a fire, even if one earth is through a house secondary; that is to say, if in one house the primary is in contact with the secondary in the transformer, the secondary will have been already earthed on one side by leakage. The plates are all made interchangeable, so that when the foil has acted it is merely necessary to slide in some fresh plates.



FIGS. 1 AND 2.—THE CARDEW EARTHING DEVICE.

It has been suggested that the permanent earthing of the secondary does all that the static contact will do. Earthing the middle of the secondary circuit reduces the stress on the secondary insulation, but admits of danger from fire, as it only requires one leak to earth on the secondary to make a short circuit. With the static contact two are needed.

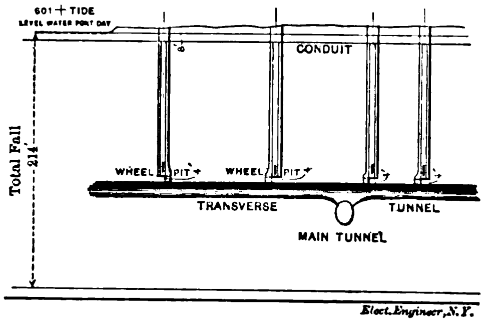
It is evident that the apparatus can be modified to act as a relay, and cut off both poles of the circuit, or to ring a bell and drop a danger disc, as has been arranged for the Chelsea Electric Supply Co., where continuous currents are used.

This apparatus has been adopted by the Deptford Co., the Newcastle Electric Supply Co., the Lynmouth Central Station Co., the Shanghai Electric Co., and others.

UTILIZING NIAGARA.

For many years past engineers and manufacturers have discussed plans for utilizing the enormous power available for manufacturing purposes in the Falls of Niagara, and since the transmission of power by electricity has become a reality, these discussions have been given renewed vigor. About four years ago a company was formed for the purpose of putting the ideas long held into practical operation, and, as a result of a thorough study of the problem involved, is now preparing to carry out its plans, as recently announced by us.

The Niagara Falls Power Co., as the organization is called, propose to adopt, with slight modification, the plans of the late engineer, Thomas Evershed, which embody the construction of a submarine tunnel from the water level below the Falls, about 200 feet under the high bank of the river, extending through the rock to the upper Niagara River at a point about one mile above the Falls, where a head of 120 feet is obtained. The tunnel thence extends parallel with the shore of the river one and one-half miles at an average depth of 100 feet below the surface of the earth, and at a distance of about 400 feet from the navigable waters of the river, with which it is connected by means of conduits or lateral tunnels.



Elect. Engineer, N.Y.

FIG. 1.—THE NIAGARA TUNNEL.

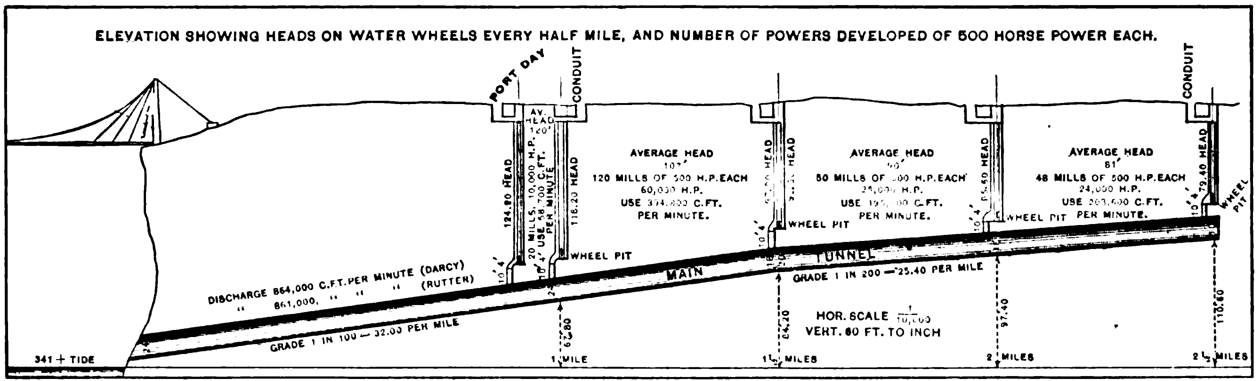
The construction to be adopted is shown in the accompanying engravings. It is proposed to construct the main tunnel of an area equivalent to a circle 24 feet in diameter. Its mouth will be located as low as high water below the Falls will permit, and it will have a descent from a point half a mile above Port Day to its mouth of one in 100, or $52\frac{80}{100}$ feet per mile. Above Port Day the tunnel will gradually diminish in size, in accordance with the number of mills which have yet to empty their tail-waters into it, until at the upper end it will be of the same area as the cross tunnels which flow into it at that point.

Sufficient land along the river has already been secured, surveyed and apportioned into mill sites fronting on the river and on the line of the proposed tunnel with ample streets and dockage, affording facilities for approach by rail or water, to accommodate 238 mills of 500 h. p. each, or 119,000 h. p. in all, which is the engineers' estimate of the capacity of the tunnel proposed to be built.

On April 1 a contract was signed between the Niagara Falls Power Co. and the Cataract Construction Co., of New York, for the construction of the work, the cost of which will amount to $3,500,000.

The officers of the company are: President, Chas. B. Gaskill; treasurer, Francis R. Delano; secretary, Alex. J. Porter; attorneys, W. Caryl Ely, W. B. Rankine; resident engineer, Albert H. Porter.

While the present plan contemplates only the direct application of the great water power at the Falls, its transmission to the city of Buffalo is now also being considered. Indeed, we may state, that for some time past Mr. Edison has been engaged on the question, and one of the plans suggested by him is the transmission of current under a pressure of several thousand volts, by means of a cable laid in the Niagara River. A canvass of the city of Buffalo has shown that between 40,000 and 50,000 h. p. is in use there at the present time which could be largely augmented by the application of cheaper power transmitted from Niagara.


ELEVATION SHOWING HEADS ON WATER WHEELS EVERY HALF MILE, AND NUMBER OF POWERS DEVELOPED OF 500 HORSE POWER EACH.
PORT DAY
CONDUIT
AV. HEAD 120'
124.80 HEAD
20 MILLS, 10,000 H.P. USE 58,700 C.FT. PER MINUTE
118.20 HEAD
WHEEL PIT
AVERAGE HEAD
120 MILLS OF 500 H.P. EACH
60,000 H.P.
PER MINUTE.
HEAD
WHEEL PIT
AVERAGE HEAD
50 MILLS OF 500 H.P. EACH
PER MINUTE.
HEAD
WHEEL PIT
AVERAGE HEAD 81'
48 MILLS OF 500 H.P. EACH
24,000 H.P.
PER MINUTE.
CONDUIT
79.40 HEAD
WHEEL PIT
DISCHARGE 864,000 C.FT. PER MINUTE (DARCY)
" 861,000 " " " (RUTTER)
MAIN TUNNEL
GRADE 1 IN 200 — 25.40 PER MILE
GRADE 1 IN 100 — 32.00 PER MILE
HOR. SCALE 1/10,000
VERT. 60 FT. TO INCH
62.80
64.20
97.40
110.60
341 + TIDE
1 MILE
1½ MILES
2 MILES
2½ MILES

Elect. Engineer, N.Y.

FIG. 2.—THE PLAN FOR UTILIZING THE WATER POWER OF NIAGARA RIVER.

THE WARD AND SLOAN BATTERY.

BY PROF. A. E. DOLBEAR.

In The Electrical Engineer of June, 1888, there is an excellent paper on galvanic batteries, their possibilities and limitations.[1] There are numerous tables giving the calculated and observed electromotive forces due to various elements and liquids, etc., and among these the highest given for any combination is that due to magnesium combining with chlorine, namely, 3.1 volts. The calculated E. M. F. being 3.24 volts. . The highest E. M. F. obtained with zinc is 2.2 volts when combining with hydrochloric acid.

On looking over those carefully prepared tables and considering their meaning one would be quite likely to come to the conclusion that the ground had been so well worked over that it would be a waste of time for one to attempt, with common materials, to produce a cell that should be superior to those already known. Of course, if magnesium was commercially available so as to be a competitor with zinc for battery purposes, much higher efficiency could be obtained, but if one has had to depend upon zinc and common reagents, there has not been anything to encourage him to think that any improvement was possible.

For about fifty years we have had the Grove cell and the Bunsen cell, (though I think that Silliman of Yale College used this form and described it before Bunsen), these having electromotive forces of about 1.8 and 1.9 volt, respectively; and we have had the bichromate cell with 2 volts.

Any considerable departure from these in the way of higher electromotive force was not to be expected. Electricians will therefore be pleased to know of a galvanic cell nearly fifty per cent. better than either of those mentioned. I examined this cell some time ago and announced finding an electromotive force of 2.87 volts, whereat one of the English electrical papers declared that it did not believe it.

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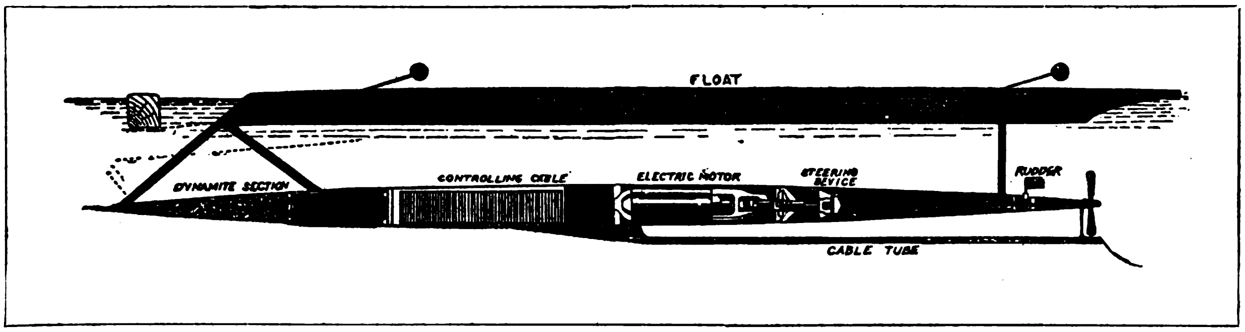
[1] The Possibilities and Limitations of Chemical Generators of Electricity. By F. B. Crocker. A paper read before the American Institute of Electrical Engineers.

As it was subject to the condition of obtaining a patent, it was at the time inexpedient to give the particulars about the cell. As that condition no longer obtains I give the directions for making such a cell and anyone may verify the statement for himself.

The zinc is put into a solution of sodium hydrate NaOH, and the carbon into a porous jar containing strong nitric acid, HNO_3, and chromic acid, CrO_3, to which is added some common salt. The proportions of these are: To one-half a gallon of HNO_3 add one and a half pounds of CrO_3 and one pound of salt. The internal resistance of a cell depends upon its size, etc., and the above quantities are for a cell 12 x 12 x 9 inches. The zincs being the equivalent of 24 rods half an inch in diameter, such as are in common use in Leclanché cells; the carbons are the equivalent of 50 electric light carbons.



THE EDISON-SIMS ELECTRIC TORPEDO.

That was the way these elements were disposed in the cells I examined. Such a cell had an internal resistance of about one-tenth of an ohm, and was capable of giving a current of 10 amperes, or more, all day. One such cell gave 10 amperes for 30 hours continuously, when its internal resistance was found to be but .13 ohm and its electromotive force 2.32 volts.

I have since that time measured such cells having 2.9 volts.

The chromic acid made from alkaline chromates is better than the ordinary, and that manufactured directly from the chromate of iron has been found to give decidedly better results than that ordinarily to be bought. The discoverers of this cell are Messrs. Ward and Sloan of Boston, who hit upon it by a system of trials with various chemicals. Such a hotch-potch would not likely be suggested by any theory of things and leads one to think it may not be unlikely that other common stuff lying round may have in it the possibility of still further increasing the usefulness of the primary battery.

TRIAL OF THE EDISON-SIMS TORPEDO.

FOR some time past experiments have been going on at the Willett's Point Government station in the trials of the Edison-Sims electric torpedo, and last week a large party, including a number of foreign army and navy officers, were invited to an exhibition of the same.

The accompanying engraving shows the torpedo in section. It consists of a cylindrical hull of copper, with conical ends, 28 feet long by 18 inches in diameter, and is supplied with a small screw and a rudder. The hull, carrying the dynamite section, controlling cable, electric motor, and steering gear, is supported at a submerged depth by an indestructible float attached to the hull by an upright steel stanchion. As the boat moves, only the top shell of this float is visible, carrying little rods showing signal flags or balls. This float, against which the Gatling and Hotchkiss guns of the enemy would be vigorously directed, is claimed by its inventor to be entirely impenetrable. The hull and float are protected from cables, ropes, or other obstructions by a sharp steel blade set at such an angle as to make the boat dive under or cut away the obstacle.

The electric current from the dynamo machine on shore is conveyed to the torpedo by a cable stored in one of its sections, which is paid out as the torpedo proceeds on its errand. The operator from his station on shore or on shipboard can at will start, stop, or steer the torpedo to port or starboard and explode the charge, which can also be arranged to explode by contact if desired, and he receives notice when the hull or blade meet with any obstruction, together with the magnitude of the same, thus making sure of the proper moment for explosion.

Owing to the great expense no torpedo was exploded during the trials, but the work done by the fixed mines viewed in connection with the operations of the torpedo boat, satisfied the visitors as to the results obtainable.

Steering is effected by a powerful electro-magnet, into which is switched the main current by means of a polarized relay actuated by the current of the shore battery. Two keys control the relay in the boat, and the rudder is thus thrown from side to side.

THE DIATHERMANCY OF AIR IN RELATION TO THE EFFICIENCY OF INCANDESCENT LAMPS.[1]

BY F. HIGGINS.

IT is occasionally useful to know something of the state of the vacuum in incandescent lamps without injuring them by perforating the bulb with electric discharges. The property which air possesses of transmitting radiant heat in proportion to its density, affords a means for obtaining this information. I have not seen any mention of this property in works on the subject which I have consulted, and do not know whether my results agree with others, which may have been obtained.

In order to make some comparative tests, I obtained, through the kindness of Major Flood Page, a number of lamp-bulbs fitted with similar filaments of platinum-iridium as nearly as possible alike in length. Some of these bulbs were exhausted to the highest possible degree, some left open to the air, and others exhausted to a pressure equal to 1-10th inch of mercury. With a sensitive thermoscope the different qualifications of the three descriptions can be made apparent. The lamps of each class being very similar in their behavior, it is only necessary to give the results obtained with one of each type. The highest possible exhaustion is that which is supposed to be the condition of the electric lighting bulbs; the 1-10th inch gives a vacuum like that necessary for the Geissler tubes; the air-bulb, as before mentioned, open to the air.

By means of adjustable resistance and batteries, the three lamps were brought to the same degree of red heat, as nearly as could be judged. The potential at the filament terminals and the volume of current flowing were measured in each case, with the result that the air-bulb required, to produce the red heat, 7.02 watts; the 1-10th inch vacuum, 5 336 watts; and the highest possible, 0.646 watts only. With the same lamps in series the highest possible becomes white hot with a current which scarcely causes visible redness in the air-bulb filament, and only dull redness in the 1-10th inch vacuum. The relative conductibility of the three bulbs as measured by radiation upon a sensitive thermoscope, was—

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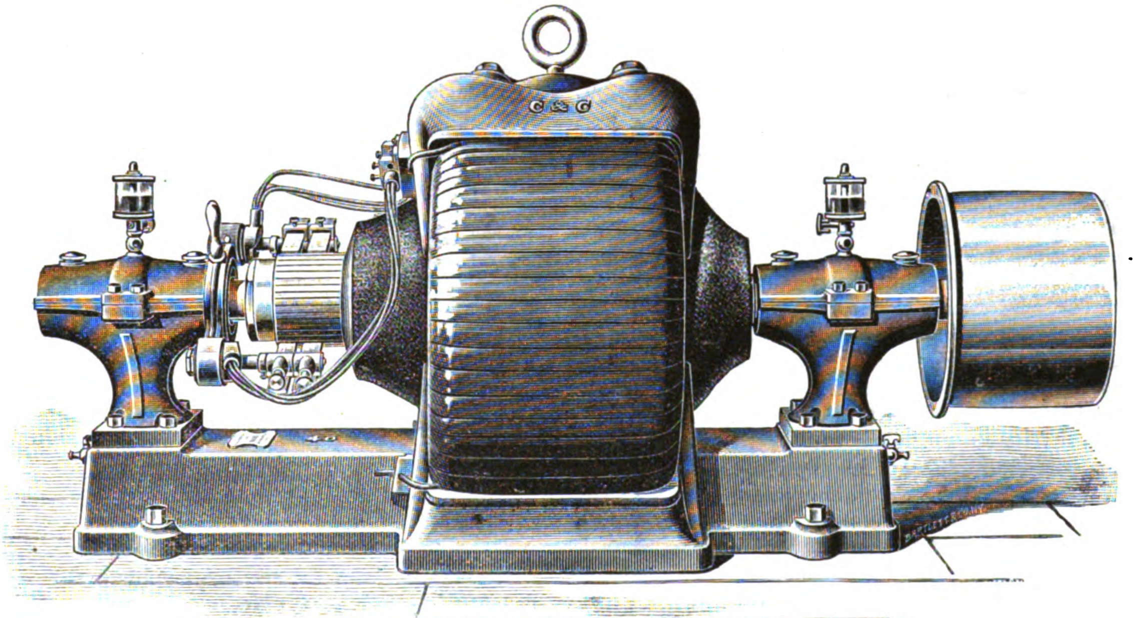
[1] Paper read before the London Institution of Electrical Engineers, April 10, 1890.

Air, 325°.
1-10th inch vacuum, 250°.
Highest possible, 35°.

When the same filaments were raised to incandescence, that in the air-bulb required 31.2 watts per candle; the 1-10th vacuum, 15.20 watts per candle; and the highest possible vacuum, 4 watts only per candle.

These results show that of two similar lamps, one, merely from imperfect vacuum, may require double the current that is necessary in the other to produce the same amount of light, and at the same time become dangerously hot. The two extremes of my scale show, for example, the absorption of nearly eight times the force in the case of the air-bulb that is necessary to produce the same effect in the most efficient lamp with a higher vacuum. It is possible that vacua produced by chemical absorption of carbonic gas may be more perfect even than this, and advantageous to use. There is always some air left in a vacuum produced by a pump; but it is possible to imagine that no gas will be left unabsorbed in the case of caustic potash and carbonic acid gas being employed. Lamps which differ much in the state of their surrounding medium differ also in their behavior when current is applied. Those which have a very perfect vacuum attain incandescence slowly, and lose it in the same way; while those which are imperfect start suddenly into incandescence, and as suddenly lose it.



C. & C. 25-H. P. Motor.

THE IMCHENETZKI BATTERY.

In this battery the exterior containing cell is of tinned iron, with a base of cast iron. The interior cell, open at the base, is of paraffined cardboard, and contains eight porous diaphragms. Melted paraffin wax is poured at the bottom of the first cell, and when this is cold the second is introduced. There are thus nine compartments perfectly insulated, of which four contain sulphite of soda with plates of zinc, and the other five are filled with chromic acid, with electrodes of specially prepared compressed graphite. In certain types both electrodes are of graphite. The E. M. F. of this battery is 2.12 volts, or 0.8 volt if both electrodes are of graphite. The battery, when short-circuited, gives a very constant current for several hours.

25 HORSE POWER C. & C. ELECTRIC MOTOR.

As our readers may be aware, the C. & C. Electric Motor Company of this city have for some time past been engaged in remodeling their various types of motors, and have adopted a uniform type embodying the circular form of magnet for all their standard sizes from 1 to 50 h. p.

The accompanying engraving illustrates the most approved and latest form of their twenty-five horse power motor. The most striking feature of these machines is the shape of the magnetic circuit which forms a perfect circle around the centre of the armature shaft. This construction gives the shortest possible magnetic circuit, being free from corners and projections where leakage might occur and making the motor very compact for a given power.

The advantage of this form of construction is shown by the remarkably small current absorbed by the various sizes when running either with, and without, load. This has been conclusively proven by some recent tests in New York and Chicago. The larger sizes are fitted with self oiling bearing or sight feed oil cups as desired. The speeds are relatively slow, that of the 25 h. p., here represented, being 850 revolutions per minute. A large number of these motors are already in operation in various parts of the country.

THERMO-ELECTRIC TENSION BETWEEN COMPRESSED AND UNCOMPRESSED MERCURY.

Dr. de Coudres, of Leipzig, is reported to have succeeded in detecting a thermo-electric tension between compressed and uncompressed mercury. The compression was produced either hydraulically or by means of its own weight acting through a column of mercury. It was found possible to determine with certainty the direction of the thermo-electric current, and to measure its intensity for given pressures and temperatures.

ON THE SPECIFIC RESISTANCE OF METALS AND ALLOYS.

BY GEORGE B. PRESCOTT, JR.

(Concluded from page 291.)

As Professor Jenkin points out, the values calculated from the metre-millimetre column and true specific gravity will not agree with the underlined values given in Table II., p. 291. This is no doubt due to the reprehensible practice of referring conductivities to some metal such as silver, which has rendered valuless numerous most careful experiments by skilled electricians; for no two of them take as their standard metal one with the same conductivity, nor are the relative conductivities known; so that even Dr. Matthiessen's experiments do not allow of the construction of a perfectly satisfactory table.

Briefly stated, Professor Jenkin's table was constructed by taking for its basis the resistance of a metre-gramme of lead of a certain specific gravity, as given by Dr. Matthiessen, in Table I, and calculating the values for the other metals from their relative conductivities, as also determined by Dr. Matthiessen, by taking such specific gravities as he considered the most reliable. It has been shown above that the values so obtained do not agree with the actual measurements made by Dr. Matthiessen, of silver, coper, gold, mercury, and the gold-silver alloy, and this difference may be partly due also to the fact that the wires experimented on by Dr. Matthiessen had a different density than those Professor Jenkin employed.

Dr. Matthiessen's own values for the relative conductivity of the metals and alloys (presumably the values employed by Professor Jenkin in constructing his table) together with the specific gravities and equivalents of the metals which he uses in his experiments, are given in Table III. This has been compiled from two tables contained in an original communication[1] by Dr. Matthiessen, with the exception of a few numbers not given there, which have been derived from Professor Jenkin's Cantor lectures in the B. A. report. On comparing Tables II. and III. the marked difference between the specific gravities used by Dr. Matthiessen and Profesor Jenkin will be observed.

The German silver wire which was used by Dr. Matthiessen as the standard of comparison in all of his experiments, is commonly referred to in the text books as the "alloy usually used for resistance coils," and its composition is never mentioned, although that of all other alloys is carefully stated. This omission has been rectified in this table, and the proportions of its constituent metals as analyzed by Dr. Matthiessen are given.

In a later paper[2] Dr. Matthiessen has himself prepared some resistance tables, based on assumed specific gravities and calculated from his determinations of the relative conducting powers of the metals and alloys as compared with pure silver, and from the actual resistance which he found for hard drawn wires of silver, copper, gold and the gold-silver alloy, and for lead and mercury. The figures from two of these tables have been combined in Table IV. It will be noticed that while the metre-gramme column in this table corresponds in the main with Table I., there is a slight difference in the figures for mercury and a greater difference in the figure for silver. Accounting for this discrepancy by the fact that the silver wire used was drawn in a peculiar manner, Dr. Matthiessen proceeds to give another table (Table V.) which was calculated by taking the conductivity of the gold-silver alloy 7.148 = 15.03, and the resistance of a metre-gramme as 1.668 B. A. units; and obtaining the resistance of the other metals from their relative conducting powers as given in Table III. This results in a different value for the conducting power or resistance of silver and mercury than would be obtained by calculating these values from Table IV.; for, if the specific conducting power of silver, 48.83, as given in Table IV. is taken as 100, then the specific conducting power of the gold-silver alloy as given in that table would be 14.64, a difference of 2.6 per cent.; which is too great to be accounted for by the difference between the two values for silver.

Although there does not appear to be any explanation of this discrepancy except that Dr. Matthiessen preferred the earlier determinations, it would seem as if the figures in Table V.. should be taken as representing the values which he would give for the specific resistance of the metals according to his determinations. If the value 0.1682 which is given in Table I., for the resistance of a metre-gramme of hard silver be reduced by using the specific gravity 10.5, then the resistance of a metre-millimetre will be 0.0204, which agrees very closely with Table IV., while both differ by about 2.3 per cent. from the figure in Table V. It seems probable that these differences may have arisen from calculating the resistances from the relative conductivities of the metals as compared with those of silver and the gold-silver alloy.

TABLE III.

Relative Conducting Power, Specific Gravity and Equivalents of the Metals Experimented on by Dr. Matthiessen.

From Philosophical Transactions, 1864.

Metals.	Specific gravity.	Equivalent.	Conducting power.
Silver, hard	10.468	108.	100.00
" annealed			108.57
Copper, hard	8.95	31.7	99.95
" annealed			102.21
Gold, hard	19.265	197.	77.96
" annealed			79.33
Aluminium, annealed			56.06†
Zinc, pressed	7.148	32.6	29.02
Platinum, hard	21.4		17.99
" annealed			18 03†
Iron, hard or annealed	7.79		16.81†
Nickel, annealed	8.50		13.11†
Tin, pressed	7.294	58.	12 86
Lead, pressed	11.376	103.7	8.32
Antimony, pressed			4.62
Bismuth, pressed	9.822	208.	1.245
Mercury, liquid	13.557		1.72§
Platinum-silver alloy, hard or annealed	12.§		6.7§
Gold-silver alloy, hard	15.18§		15.03
*German-silver, hard or annealed	8.74§		7.8§

* By analysis volumes, per cent., Ni, 12.84; Zn, 36.57; Cu, 50.59.
† Calculated from the impure metals by Dr. Matthiessen.
§ Jenkin's Cantor lectures.

If mercury is taken as the standard the differences are still more marked, and Professor Jenkin found that the disagreement between a London and Berlin Siemens mercury unit was as great as 1.6 per cent. The re-determination of the value of the ohm in terms of the resistance of mercury has served to still further increase the discrepancies, when comparison is made between the new value and the earlier determinations of the specific resistance of mercury.

Siemens' determinations of the resistance of mercury were made for given weights and lengths and converted to resistance per unit volume by using the specific gravity 13.557. The B. A. committee found that 1 B. A. unit = 1.046 Siemens 1864 unit, when corrected by using the specific gravity, 13.595, from which it follows that a column of mercury 1 metre long and one square millimetre section (=1 Siemens unit) has a resistance of 0.9537 B. A. unit. In terms of the B. A. unit, therefore, the specific resistance of mercury (cubic-centimetre) = 95,370 C. G. S. units. By the definition of the 1884 Paris Congress a column of mercury 106 centimetres long and 1 square millimetre cross section at 0°C. has a resistance of 1 legal ohm, according to which the specific resistance of mercury = 94,340 C. G. S. units. Therefore,

1 legal ohm = 0.9889 B. A. unit.
1 B. A. unit = 1.0112 legal unit.
Difference 1.12 per cent.

According to Matthiessen (Table IV,) the resistance of a column of mercury 1 metre long weighing 1 gramme at 0°C. = 13.071 B. A. units. Taking the specific gravity = 13.595 the specific resistance in terms of the B. A. unit is found to be 96,146 C. G. S. units ; from which it follows that—

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[1] Philosophical Transactions, 1864.

[2] Philosophical Magazine, 1865.

1 B. A. unit = 0.98122 legal ohm .
1 legal ohm = 1.0191 B. A. unit.
Difference 1.88 per cent.

As given in Jenkin's table the specific resistance of mercury in terms of the B. A. unit is 99,740 C. G. S. units, and comparing this as before, with the Paris value,

1 B. A. unit = 0.94586 legal ohm.
1 legal ohm = 1.0572 B. A. unit.
Difference, 5.46 per cent.

It is now possible from the information so far obtained, to trace the source of the disagreements between the various electrical text books: In Maxwell's *Electricity and Magnetism*, Table IV. is copied from the *Philosophical Magazine*, and a column added, giving the specific resistances in C. G. S. units. In Everett's *Units and Physical Constants*, Maxwell's table is copied, and in the later edition of this work (1886) the values are corrected to legal ohms by subtracting 1.88 per cent. (derived as above,) from the numbers in the specific resistance column, excepting mercury, which is valued according to the Paris definition. On the following page two of the columns from Jenkin's table are given, the numbers having been corrected by subtracting 1.88 per cent. in the same manner, mercury excepted as before. The juxtaposition of these two tables, both based on Matthiessen's experiments, makes their disagreement glaringly conspicuous.

Stewart and Gee, in their *Practical Physics* also extract two columns from Jenkin's table in terms of B. A. unit without reduction, although the book appeared as late as 1887. In Ayrton's *Practical Electricity* the same two columns are also taken from Jenkin, and the numbers reduced to legal ohms by multiplying each by the constant 0.9889, obtained as explained above; but here also the value for mercury has been altered to correspond with the definition of the legal ohm.

TABLE IV.

Specific Resistance of the Metals in B. A. Units at 0° C.

Compiled from Paper by Dr. Matthiessen in *Phil. Mag.*, 1865.

Metals.	Specific gravity.	Resistance per metre gramme.	Hard drawn round wires 1 metre long, 1 millimetre diameter.	
			Resistance.	Conducting power.
Silver, hard drawn	10.50	0.1689	0.02048	48.83
Copper, " "	8.95	0.1469	0.02090	47.85
Gold, " "	19.27	0.4150	0.02742	36.47
Lead pressed.....	11.391	2.257	0.2527	3.957
Mercury, liquid...	13.595	13.071	1.224	0.8172
Gold-silver, alloy, of the wire. ...	15.218	1.668	0.1399	7.148

In the new small edition (1889) of Gray's *Absolute Measurements* Jenkin's table is reprinted in full and corrected to legal ohms by subtracting 1.12 per cent. from all the numbers with the exception of those for mercury, which is reduced by some arbitrary constant to have a specific resistance of 95,110 C. G. S. units. On another page Professor Gray gives a table of the resistance of pure copper wires drawn to the English standard gauge which has been calculated by taking 1.624 C. G. S. unit as the resistance of a cubic centimetre of hard drawn copper, as given by Matthiessen in the *Philosophical Magazine*, (Table IV.) A foot note to the Jenkin's table says :—" According to the determination of the specific resistance of mercury referred to above (viz.: 106 centimetres, 1 square millimetre = 1 legal ohm) the value given in this table is about 0.8 per cent. too high." And again :—" The value given in this table in column I. (cubic centimetre) for hard drawn copper, has evidently been calculated from the corresponding observed result in column III. (metre-gramme,) by using the density 8.89 for copper, and is, therefore, higher than that on which the standard wire table is founded."

There is also a typographical error in the Jenkin's table as given in this book, the resistance of a cubic centimetre of hard copper being given as 1,534 instead of 1,634 C. G. S. units. Another misprint in the foot note states that the length of a column of mercury having one B. A. unit resistance is 0.1048 centimetres instead of 104.8 centimetres, as it should be.

It may be mentioned also that a table of the resistance of annealed pure copper wires drawn to the English standard wire gauge, which was printed by the London *Electrician*, and a similar table for the American gauge compiled by the writer, both published several years ago, were founded on the resistance of the Matthiessen standard mile unit as defined in the B. A. report. This happens to be the lowest of all the figures for copper, and more nearly corresponds with later observations than any of the others.

In order that these conflicting figures may be conveniently compared, those for silver, copper, lead and mercury, as found in the various books referred to, have been reduced to legal ohms, and will be found in Table VI.

The facts brought to light by this investigation not only explain the causes of the conflicting values for the resistance of metals now current, but seem to indicate as well, that even Dr. Matthiessen's researches are not all that could be desired. In fact it is not infrequently the case that samples of commercial copper wire on being subjected to careful tests, have been found to actually possess a higher conductivity than that assigned to absolutely pure copper. Numerous instances of this fact were given by Willoughby Smith, some years ago, in a communication addressed by him to the Society of Telegraph Engineers, in which some samples came out four per cent. in excess of the standard of pure copper.

TABLE V.

Specific Resistance of the Metals and Alloys in B. A. Units. Calculated by Dr. Matthiessen, Taking Conducting Power of Gold-Silver Alloy 7.148 = 15.03.

From *Phil. Mag.*, 1865.

Metals.	Round wires, 1 metre long, 1 millimetre diameter.	
	Specific conductivity, 0° C.	Specific resistance, 0° C.
Silver, hard....................	47.56	0.02103
" annealed	51.63	0.01937
Copper, hard..................	47.53	0.02104
" annealed	48.61	0.02057
Gold, hard.....................	37.06	0.02697
" annealed	37.73	0.02650
Aluminium, annealed..........	26.66	0.03751
Zinc, pressed..................	13.80	0.07244
Platinum, annealed............	8.58	0.1166
Iron, annealed.................	7.99	0.1251
Nickel, annealed...............	6.23	0.1604
Tin, pressed....................	5.88	0.1701
Lead, pressed..................	3.96	0.2527
Antimony, pressed............	2.19	0.4571
Bismuth, pressed..............	0.591	1.689
Mercury liquid................	0.788	1.270
Platinum-silver alloy..........	3.18	0.3140
German silver..................	3.71	0.2695
Gold-silver alloy............ ...	7.148	1.668

Note: The sp. grav. of copper used was 8.95. Siemens found it to vary for a wire between 8.89 and 8.92 ; using the value 8.91 the conducting power would be 47.64.

The writer some time ago[1] suggested that it would be a very desirable thing if some institution with facilities such as are possessed by the Johns Hopkins University, would undertake the re-determination of the resistance of copper, prepared by modern process of manufacture. It now seems even more desirable than ever that some competent electricians should repeat Dr. Matthiessen's experiments, taking care, however, to avoid the errors into which he fell.

One other matter which it is pertinent to touch upon in connection with this subject, is the work done by Dr. Matthiessen and his colleagues in determining the effect of temperature on the resistance of metals. While the text books usually give a mean formula derived from his experiments, taken from Jenkin's Cantor lectures in the B. A. reports, it does not appear to agree with the mean formula given in Dr. Matthiessen's original

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[1] THE ELECTRICAL ENGINEER, June, 1888.

TABLE VI.

Specific Resistance of Silver, Copper Lead and Mercury, at 0° C., in Legal Ohms.

According to Various Authorities.

Reference.	Silver, Hard.			Silver, Annealed.			Copper, Hard.			Copper, Annealed.			Lead, Pressed.			Mercury, Liquid.		
	Specific gravity.	Resistance.		Specific gravity.	Resistance.		Specific gravity.	Resistance.		Specific gravity.	Resistance.		Specific gravity.	Resistance.		Specific gravity.	Resistance.	
		Metre-gramme.	Cubic centimetre.		Metre-gramme.	Cubic centimetre.		Metre-gramme.	Cubic centi-metre.		Metre-gramme.	Cubic centi-metre.		Metre-gramme.	Cubic centi-metre.		Metre-gramme.	Cubic centi-metre.
		Ohms.	C. G. S.		Ohms.	C. G. S.		Ohms.	C. G. S.		Ohms.	C. G. S.		Ohms.	C. G. S.		Ohms.	C. G. S.
[1]Matthiessen, *B. A. Rep.*, 1864.............		0.1663						0.1453						2.232			12.915	
[1] " *Phil. Mag.*, 1865, Table IV., herein	10.50	0.16703					8.95	0.1453	1624				11.391	2.232		13.595	12.926	
[1] " " " " " V. "			1633			1504	8.95		1634			1598			19627			98639
[1] " *B. A. Rep.*, 1864, stand. mile unit.												*1553						
[1]Jenkin's *B. A. Rep.*, 1873, and *Elec. & Mag.*.	10.17	0.1661	1634	10.15	0.1527	1504	8.89	0.1453	1634	8.91	0.1424	1598	11.376	2.232	19630	13.578	12.915	98633
[1]Maxwell, *Electricity and Magnetism*......	10.50	0.16703	1591				8.95	0.1453	1624				11.391	2.232	19627	13.595	12.926	95079
Paris Congress, 1884..................																		94340
Ayrton, *Practical Electricity*............			1634			1504			1634			1598			19630			94320
[1]Stewart & Gee, *Practical Physics*.........						1504						1598			19630			98633
Gray's *Ab. Measurements*, Jenkin's table..		0.1661	1634		0.1527	1504		0.1453	1634		0.1424	1598		2.232	19630		12.92	95110
" " " wire table......									1624									
Everett, *Units & Phys. Const.*, Max. table..	10.50		1579				8.95		1611				11.391		19474	13.595		94340
" " " " Jenkin's table.			1620			1492			1620			1584			19468			94340

1. Reduced to legal ohms by multiplying by .9889.
*Corrected for temperature by Matthiessen's formula for pure copper.

paper[2] on that subject. Table VII. is taken from the paper referred to as embodying the results of these researches.

TABLE VII.

Conductivity of the Metals at t° C.

$$c_t = c_0 \, (1 - at + b\,t^2).$$

Conductivity at 0° = 1.

From Dr. Matthiessen's Experiments, *Phil. Trans.*, 1862.

Metals.	Conductivity at t° C.
Silver............	$1 - 0.0038287\,t + 0.000009848\,t^2$
Copper.........	$1 - 0.0038701\,t + 0.000009009\,t^2$
Gold..	$1 - 0.0036745\,t + 0.000008443\,t^2$
Zinc......	$1 - 0.0037047\,t + 0.000008274\,t^2$
Cadmium.........	$1 - 0.0036871\,t + 0.000007575\,t^2$
Tin.....	$1 - 0.0036029\,t + 0.000006136\,t^2$
Lead.............	$1 - 0.0038756\,t + 0.000009146\,t^2$
Arsenic...........	$1 - 0.0038996\,t + 0.000008879\,t^2$
Antimony....... ...	$1 - 0.0039826\,t + 0.000010364\,t^2$
Bismuth..........	$1 - 0.0035216\,t + 0.000005728\,t^2$
Means.........	$1 - 0.0037647\,t + 0.000008340\,t^2$
Iron...........	$1 - 0.0051182\,t + 0.000012916\,t^2$

The value of the constants a and b, for calculating the resistance of pure metals at t° C., when their resistance at 0° = 1, may be obtained by taking the reciprocal of the above formula, thus:—

$$\frac{1}{1 - at + bt^2} = 1 + at + (a^2 - b)\,t^2.$$

$$\therefore\ r_t = r_0\,[1 + at + (a^2 - b)\,t^2].$$

Thus the formula for pure copper would be—

$$r_t = r_0\,(1 + 0.0038701 + 0.000005969.)$$

The above formulæ, excluding that for iron, agree closely, from which fact Dr. Matthiessen thinks that the law may be deduced that all pure metals in a solid state vary in conducting power between 0° and 100° to the same extent; more especially as he found that wires of one and the same metal showed almost the same differences as were found between the mean results obtained for the different metals.

WATER POWER UTILIZED AT WATSONVILLE, CAL.

One of the best examples of the utilization of waste water that has come under our notice, says the *Mining and Scientific Review*, is that recently made at Watsonville in California. The Corillitos Water Co. of that place get their supply from Corillitos creek, at a point 7½ miles from the town. Their distributing reservoir is located 1½ miles distant at an elevation of 90 feet. The water is brought from the Corillitos creek six miles above, in a 15-inch pipe, and discharges into the reservoir under a considerable head. It occurred to the water company not long ago that this pressure might be used to light the town, and after conference with the Pelton Wheel Company, of San Francisco, the scheme was found to be perfectly practicable and a contract was at once entered into with that company to erect the power plant, and with the Thomson-Houston Co., for the electric installation.

The plant consists of a 4-foot Pelton wheel, which runs under a pressure of 60 pounds, equal to a head of 140 feet, the water being discharged on to the wheel through a 2¼-inch nozzle. Close regulation is afforded by a deflecting nozzle and hydraulic governor, which gives perfect steadiness to the lights. The dynamo is a T. & H. alternating current, which runs 300 16-candle power incandescent lights, the current being carried to the town, 1½ miles distant.

The power thus furnished, it will be seen, is from the waste water that has heretofore been absolutely valueless, and is so much clear gain to the company, the cost of operating the plant being almost nominal. The water after leaving the wheel falls into the reservoir, having been areated and freshened to as great an extent as though it had been dashed over a cataract, thus incidentally accomplishing without expense just what is so much needed in such cases. This plant has been in successful operation some three months, and it is now proposed to put in an ice machine and thus utilize the power wasted during the day. There are probably hundreds of places all over the country where this same experiment can be repeated with corresponding results.

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[2] THE *Philosophical Transactions*, 1862.

THE GILLETTE MAGNETO BELL.

The care and attention required by electric batteries has made the magneto a favorite generator, as it is always ready for action and can be applied to a variety of purposes besides a calling instrument. One of the recent forms of this kind brought out is the Gillette magneto, made by the Shaver Corporation of this city. It is illustrated in the accompanying engraving, Fig. 1. The great powers of this magneto are due largely to the shape of the steel magnets. These as will be seen in Fig. 2., consist of a single round piece of steel having interior pole-pieces which are brought into close proximity to the armature. Three of these magnets are bolted together to form a single strong magnet, which entirely prevents the straying of the lines of force by concentrating them on the armature. The latter consists of a soft iron core, wound with a bobbin of wire on either end and which is revolved at high speed by the gear wheels and crank shown.

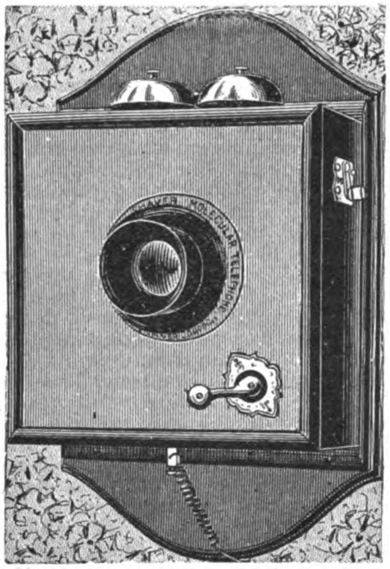

Fig. 1.—The Gillette Magneto.

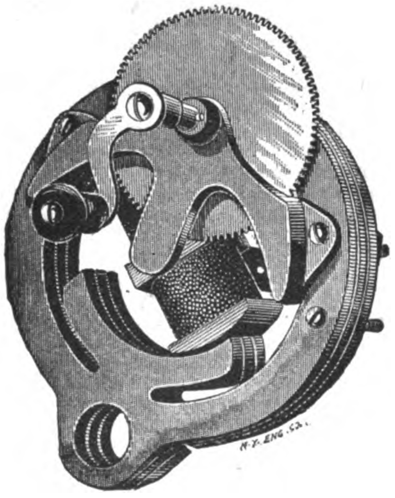

Fig. 2.—The Gillette Magneto.

The Gillette magneto is substantially made and is capable of ringing a bell through several thousand ohms resistance.

THE SOLANO HIGH SPEED REVERSIBLE ENGINE.

The practice of connecting engines direct with the shafts of dynamos is coming more and more into vogue, and engine builders are giving considerable attention to this feature. Messrs. Howard & Morse, of this city, have adapted the Solano engine to this new field after having operated the same successfully for some time on other classes of work.

The engine which is illustrated in two views in the accompanying illustrations is of the three cylinder, single-acting high speed type, and its principal feature consists in the rotary steam valve which forms but a single piece.

The receiving chambers of the rotary valve are alike; also the ports in the valve for distributing the steam. Thus, when the engine is going in one direction, the steam is admitted to one of the receiving chambers and exhausted out of the other; when the direction of the engine is reversed, the steam is admitted into what was the exhaust chamber before, and the exhaust takes the opposite chamber. To accomplish this, a steam valve controlling the direction in which the steam may be turned is employed; the other is the exhaust valve controlling the direction from which the exhaust shall flow. The two valves are connected by a link so that the movement of one is transmitted to the other, both moving together.

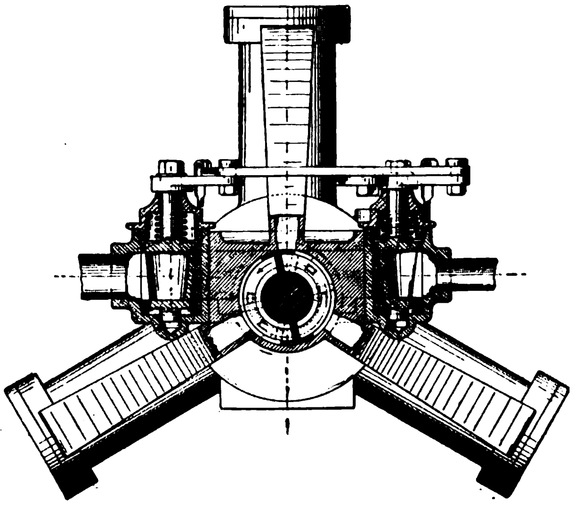

Fig. 1.—The Solano Engine.

The operation of the engine is very simple; the steam flows from the steam pipe into the steam valve, which is nothing more than a three-way cock, which, when it is in the central position of its travel, is entirely closed, stopping the engine; but, when moved in either direction the steam flows into one of the receiving chambers of the rotary valve moving the engine in the direction corresponding to that chamber. At the same time the exhaust valve which is connected to the steam valve, or cock, and which is of the same construction, turns so that the exhaust will take place from the opposite receiving chamber in the rotary valve to which steam has been admitted. Thus the direction in which the engine shall turn is simply controlled by the direction in which the steam is turned on.

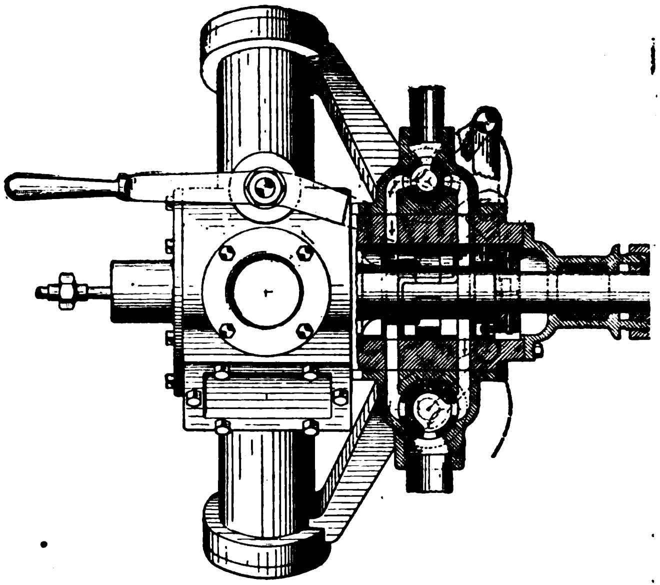

Fig. 2.—The Solano Engine.

Another important feature of the engine is that the exhaust passage in the controlling exhaust valve is such that no matter how much or how little steam the steam valve may allow to pass into the cylinder, the exhaust passage is always proportionately large, thus insuring a perfetly free exhaust at all times.

The engine is well built throughout and is provided with a sensitive governor, the engines being capable of working up to 400 revolutions per minute.

The engines have been adopted on board the Savannah Line steam ships, and the Beaver Line of Montreal has twenty of them in use at present, driving fans for obtaining draft in the boiler rooms.

SINGLE AND DOUBLE TROLLEY WIRE SYSTEMS FOR ELECTRIC RAILWAYS.[1]

BY G. W. MANSFIELD.

IN addressing you this evening on the subject of "Single and Double Trolley Wire Systems for Electric Railways" I shall endeavor to place before you precisely the advantages and disadvantages of each system. The other day while studying over the subject, the following questions arose in my mind :—Why should I spend any time whatever in discussing the two systems? Is it necessary? If so, why? I think my telephone friends here could answer that question perhaps.

I read Mr. Denver's paper with mingled pain and pleasure,—pain on account of his sufferings, and yet pleased to learn, clear at the end of the paper, that he had a remedy. The antagonism of the telephone companies to the single wire system has become universal and their love for the double wire system proverbial. This opposition has provoked much discussion and led to deep thought. My own thinking and experience has forced me to the solid conviction that for an efficient electric railway system which can be universally used, the single trolley wire is the only one to be considered. Being then, of this conviction, the time I spend upon the double trolley wire system is purely educational for my dear friends in the telephone companies and I trust I merit their hearty applause since they all tell me they want electric railways and the best,

The principles involved in the construction of a single trolley wire system are familiar to you all. You know that it can be done successfully and is done successfully. Do you, or does anyone, know that under all the conditions under which the single trolley wire works successfully the double telephone system will also work successfully?

If the difficulties with the single system have all been overcome and those of the double system have not, let us consider what we must take into account to make the latter equal the former.

With the double system the weight of the second wire, the insulators, frogs, crossovers, etc., the double liability of sleet and ice accumulating on the two wires, and the high winds all necessitate larger and stronger poles and stronger span, pull-off and anchor wires, etc. This increase in size and number of wires means additional unsightliness, a larger original outlay and an increased expense for maintenance.

One of the chief troubles which an electric railway has to contend with is to keep its trolley wire free from snow and ice during the winter months. Prompt and energetic action, with a greased trolley wire has saved the single trolley roads from any serious delay. If these same roads had had two wires to clean, I have no question but that their service would have been seriously impaired, if not entirely stopped.

I do not think that the question of traction is one of any serious moment. The rails must be cleaned for adhesion and for the cars to keep on the track irrespective of whether the single or double trolley wire system is used, and as they are get-at-able they are comparatively easily taken care of. It is simply a question of management, muscle and salt, and with improved electric sweepers and plows, there never need be any great difficulty in keeping the cars running on schedule time. The problem, however, of cleaning sleet frozen to a trolley wire placed 18 feet above ground in a large city or even on a country road is a most annoying and troublesome one.

One, if not the greatest difficulty, which would have to be overcome with the double trolley system, is the liability to leakage. The two wires hanging side by side upon the same span wire need the best of insulators. Considering all the atmospheric conditions and the possible accumulations of sleet and snow it unquestionably would be more difficult to maintain good insulation between the two wires than it is between the single wires and the ground. With the latter system you have far greater opportunities to introduce additional insulation. It can be cut into the span wire or placed on the pole, whether it be of iron or wood.

So far the under-running double wire roads have had the wires placed either six inches or eighteen inches apart. The Daft roads employ the former distance, while the Thomson-Houston Company in its attempts at Cincinnati used the latter distance. Both methods have their objections. If the wires are placed too near, strong winds may swing them together, causing short circuits. In one place the short circuit was so heavy that the wires were melted and fell into the street. With the wires farther apart plainly this trouble would not exist. With the wires close together a single trolley arm can be used. but a double trolley fork and two wheels are necessary. These wheels must be thoroughly insulated whether they rotate upon a separate or upon the same spindle. The maintenance of an insulation sufficient to withstand 500 volts under such conditions is surely not an easy task.

With the wires further apart the necessity of more than one frog at the crossings and turnouts is necessary, which is objectionable, and more than one trolley arm would have to be used. The maintenance of these trolley arms, the difficulty of keeping them on the wires, and their weight upon the roof of the cars are all serious objections. In the single wire system, questions of weight, insulation of trolley wheels, etc., practically do not enter.

Another serious objection to the double system is in the overhead switching. The placing of overhead frogs even on the single wire system requires the greatest exactitude and care, so much so that on many roads it has been found necessary to train a special gang of men to place and look after their adjustment. The expansion and contraction of the wires, and the giving and taking of the poles are constant sources of annoyance and trouble in keeping the frogs and insulators in place. The expansion of copper is about ⅓ inch per degree for 1,000 feet, or ⅝ of an inch per mile for each degree of change in temperature. If the temperature changes, as it often does, twenty or thirty degrees in a day, the trolley wire might expand or contract fifteen or twenty inches per mile. With the double trolley wire system the location and maintenance of the frogs and the cross-overs and turn-outs would, in view of these circumstances, be an extremely difficult one. They would require constant adjustment and readjustment, and if the method of placing the trolley wires 18″ or more apart was employed, so that a large number of frogs was introduced, it would practically be a determining factor between the possible and the impossible system.

On complicated systems of double track lines, the number of insulators and frogs for the double wire system would be very large. I have frequently studied such systems and have found that it is by no means a rare occurrence to meet arrangements of tracks that require from 25 to 50 overhead frogs and insulators, and in some instances from 125 to 150. The small blue prints which I have here indicate clearly what I mean. The weight of all these necessarily demands a most substantial overhead construction, and undoubtedly the only thing that could be done would be to erect large and substantial trusses. It must be also evident that the difficulty of keeping the trolley wheel upon these wires is largely increased, and also the liability of some of the ends breaking loose from a frog and falling.

Imagine such a network of wires loaded with ice on a winter's morning. Add to these wires, if you will, the necessary guard wires, and it is as essential to put up guard wires, with the double system as for the single, and I for one would not have sufficient audacity to argue for the same before a city council. It can also be clearly shown that the wires of the same polarity of the double system will not in all conditions correspond when they are attached to the frog. To illustrate what I mean, take the single track Y. If a sketch of this is made on the double wire system, it will be seen that if the right hand wire is a positive wire and the left hand wire a negative wire on a straight piece of track, and they are carried around the Y on to a branching track, the positive and negative leads are bound to conflict. Under such circumstances either the current must be broken on the motor when the car passes that point, or there will be bad flashing in the switch.

It is practically impossible to construct a frog for such a place that will permit the trolley wheels to roll across, taking current from the same continuously. There will have to be a break in the continuity of the circuit at the frog for a certain length of time. This break means the going out of the lights every time the car passes such a frog. With the single wire system, none of these difficulties are experienced. On large roads the cost of copper necessary for the double wire system would be so great as to be almost prohibitory. With the single trolley system, the earth being used as a return circuit, we obtain the aid of its conductivity and also that of the rails. Practice has demonstrated that with such an enormous conductive area the resistance of the return circuit can practically be considered *nil*. It is true that the supplementary wire of a size equal to the trolley wire is run through the earth and connected to each rail. The use of this conductor is twofold. It not only forms a good ground for each rail but it ties the whole underground system into one connected and complete metallic system. Counting the resistance of the earth as zero it is readily seen that only one quarter of the copper wire is necessary for the single system as for the double wire system. Hence a most decided saving is possible.

On a large system the subject of feeders always is a most important one. With the single trolley system it is only necessary to feed one-half of the circuit, whereas with the double trolley system it is necessary to feed both sides of the circuit. In this direction alone, therefore, the cost of the latter system must be four times that of the former, allowing for the same percentage of loss.

In regard to guard wires, I see no reason why it is not practically as necessary to place them over a double wire system as over a single. With the current passing out over one wire down through the car, through the motors under the car and back by the other wire, the chances of leakage are very great.

It would be very difficult to prevent leakages somewhere on such circuit. If a leakage should be established on the positive side of a motor armature on one car and on the negative of another, both of the cars and the station might be damaged. If these leakages are so liable, the danger from a foreign wire falling across either one of the trolley wires still exists. It is unfortunate, but nevertheless true, that arc light wires which are supposed to be thoroughly insulated from the ground, leak at times sufficiently to cause damage to life and property if a telephone or telegraph wire happens to fall across them. With bare trolley wires and with the increased chances of leakage surely the city authorities would not and ought not to permit the erection of the double trolley system without the same system of guard wires over them as is placed over the single trolley system. The expense incumbent upon the railway company in this direction therefore is equal for both systems. The danger to property in my opinion is practically equal in both systems.

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[1] Read before the Boston Electric Club, April 28, 1890.

I do not deny the fact that it is possible to so construct a simple double trolley system that a falling wire touching one of the trolley wires and with its other end on the ground, would deflect no current, nor would I deny that under similar conditions a man touching this fallen wire and standing upon the ground, would receive no shock. This is speculation, not fact, and I am not arguing this matter from a theoretical or a possible condition of affairs, but from the results of practice which teach that ordinary existing circumstances always militate against the ideal, giving as a resultant, a system materially different from what we supposed it would be.

Repeating, therefore, what I have said in regard to danger to life and property, I feel that the danger question is practically equal in both systems.

It is unnecessary for me to state to you the fact that 500 volts is not dangerous to life since I think there is no question but what you all have taken such a potential, if not higher, and I should be pleased to have any of you state, if a discussion follows this paper, whether you have taken this potential or a higher one, and the attending circumstances.

As to the relative expense of the two systems, leaving out the question of feeder wires, it is true that practically in every case the double trolley system would cost one-half as much more, if not twice as much, as the single trolley system. It may be here stated that the expense of running the supplementary wire underground is sometimes heavy. True, it is, but the expense is largely dependent upon the street through which your track passes. If it is macadamized or paved with Belgian blocks, or with any paving stones, the expense of the removal and replacement of the same would be large. Such conditions of streets, however, exist only in large cities, and here I believe it is generally conceded by friends and opponents that the double trolley system is entirely out of the question; the expense however would nowhere nearly equal the additional expense of the feeder wires for the double system, nor would it equal the cost of the maintenance of such a system for a year or two.

If, on the other hand, I admit that it is possible, but not the best system for a small road, we are happily confronted by the fact that so far in the majority of the cases, the small roads are not where it is needed, since the telephone companies, which practically represent the only opposition to the introduction of the electric railway, have not so extensive lines in these places. It is therefore the unfortunate middle man that has to suffer. In answer to all the foregoing objections to the double trolley wire system, the statement is sometimes made that there are to-day double trolley roads operating commercially successful; and that if they can operate in one place there is no reason why they can not be made to operate in all other places. Steam dummies are used to-day in some places; why do not railroad companies use them everywhere? There is scarcely anything impossible in this practical age of ours, and therefore I do not deny that the double trolley system could not be placed anywhere that the single is placed, but I unhesitatingly state and know that it could not be placed wherever the single is placed, and prove equally as satisfactory and commercially successful. It is not a question of cost but one of expediency and practicability. The electric companies would build double systems if they could guarantee them, and the railroad companies would demand them if they had confidence in them. An unbiased thinking man is forced to adopt the single system.

History shows that the efforts of the early promoters of the electric railway were to develop a double wire system with an over-running trolley. This has proved a signal failure. The only roads so operated to-day are at Easton, Pa., Elkhart, Ind., Ithaca, N. Y., Lima, Ohio, Pittsburgh, Pa., Sunbury, Pa., St. Catharines, Ont., Lancaster, Pa., Asbury Park, N. J., Appleton, Wis., and Wheeling, W. Va., eleven in all. There are none under contract, and no firm thinks for a moment of building such a system. History also shows us that the next step in progression was the development of the under-running trolley for this same double trolley wire system. Years have gone by, and we have only three companies in the whole United States having such a system in operation: these are the ones at Cincinnati, O., Meriden, Ct., and Mansfield, O. As illustrative of the feeling and confidence the street railway profession have in this system, I find there are but five companies who have contracted for such a system. I venture to assert at this point that if the conditions of the contracts for these roads were seen, most interesting and extraordinary clauses would be discovered.

If we now turn to the extraordinary development of the single trolley system, we find figures which are truly amazing. On July 1, 1888, the Thomson-Houston Company was not in the electric railway business, and the total number of roads in operation in the United States and Canada, put in by all of the electric companies who were then doing business, viz., Sprague, Daft and Van Depoele, was 33. Of these but two or three were the single wire system under-running trolley; whereas to-day there are nearly 115 roads in operation, and an equal number under contract, and of these all but some four or five have been put in or contracted for by either the Thomson-Houston company or the Sprague company. Two hundred and thirty roads contracted for the single system, five for the double. If I take the history of the Thomson-Houston company since it commenced to build electric railways, I will find that it has in less than two years put 61 roads in operation, and has under contract 45 more, making a grand total of 106 roads contracted for with the single trolley system, by one company. Could there be more conclusive proof of the pre-eminent adaptability to a commercial neccessity than this is, for the single trolley system?

The future is destined to surpass this record as surely and as amazingly as the adoption of electric lights and telephones surpassed their records of eight or ten years ago.

ELECTRIC RAILROADS IN THE CENSUS.

The use of electricity as a motive power for street cars will be an important section of the Census investigation of the electrical industry. None of the many forms of the application of electricity has been developed more rapidly or accompanied by more satisfactory results than that of the transmission of power for street car purposes.

The Census investigation of the general subject of transportation, has been very properly assigned to Professor Henry C. Adams, statistician of the Interstate Commerce Commission. He has divided the subject into several sections, one of which is "Rapid Transit in Cities." This section has been assigned to special agent Charles H. Cooley, a son of Thomas M. Cooley, chairman of the Interstate Commerce Commission.

The plan of investigation that has been adopted, is designed to make a comparison between the different motive powers employed,—animal, steam dummy, cables and electricity,—to show the relative economic value of each. Electricians can wish for nothing better than this. The only danger is, that they will experience from it an embarrassment of success. Street railroads are now being transformed into electric roads as fast as manufacturers and construction companies can take care of the business. How they will manage with an added impetus given to the business, is hard to predict. We are now witnessing the fulfillment of a prophecy made in 1889, regarding the adoption of electric motor power by all street car roads in the country.

"*The change will not be a development. It will be a transformation.*"[1]

If the investigation by the Census Office of the relative economic value of the motive powers now in use for street car service, results as I believe it will, the "horse car horse" will disappear. The places that know him now will know him no more.

The schedules for the section of rapid transit in cities will include the inquiries to be made regarding electric railroads. That part of the schedules pertaining to the electrical branch of the subject, will be prepared under my supervision, and that portion of the report pertaining to the uses of electricity as a motive power for street cars, will be embodied in my report on the investigation of the electrical industry, as well as in the report of the section making the investigation.

The Census Office is performing a service of great value for the public in making such special investigations. All who have to do with questions of municipal management or public affairs, are keenly aware of the necessity of securing reliable data by which to guide their actions. The cost of obtaining such statistics through the Census Office, is but an infinitesimal tax on the capitalization of the industries interested, while its impartial and impersonal character gives it the weight of an unquestioned authority.

Mr. Cooley is anxious to have electric railroad men impressed with the great help they can give him by filling out and returning their schedules promptly. I tell him that he will find in this, as in all other matters, electrical men lead the world. They can't help it. It is the nature of the "fluid" they imbibe to make them "quick as lightning."

ALLEN R. FOOTE, *Special Agent.*

.... THERE can be no possible argument in favor of speed as against legibility and accuracy in telegraphic work. Performances like Pollock's are, in my opinion, valueless.—*G. G. Ward.*

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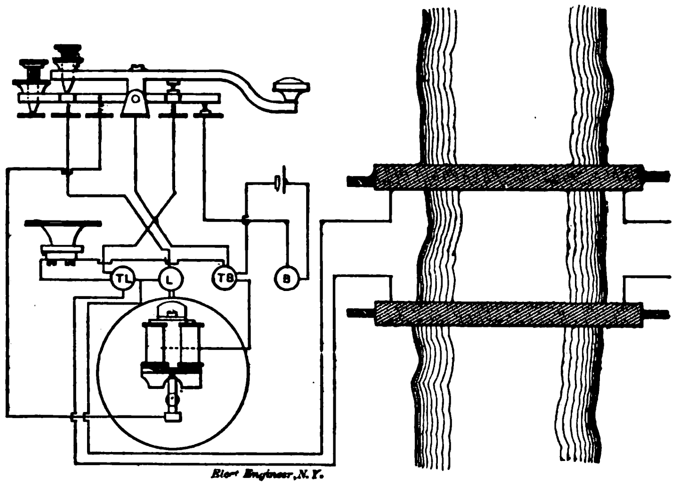
(1) "Economic Value of Electric Light and Power," p. 121.

ON SIGNALING ACROSS RIVERS IN INDIA.[1]

BY W. F. MELHUISH.

It not infrequently happens that a river cable fails entirely, or becomes imperfect at a time when, owing to the force of the stream, a new cable cannot be immediately laid, or when there is no ready-made cable available, or when a considerable period must elapse before the new cable can reach the river. To provide for these contingencies attempts have from time to time been made in India to signal across rivers without cables. Three different methods appear to have been discussed and attempted, viz.: 1. Signaling through an imperfectly insulated wire. 2. Signaling through an ordinary bare wire. 3. Signaling without any metallic conductor.

During May, June and July of the year 1888 Mr. Johnston made a long series of trials across the canal and the river Hooghly, and the subsequent measurements and experiments led him to come to the following conclusions, viz.:—That up to 1½ miles it is perfectly easy and practicable to signal through a bare wire under water; that for greater distances, judging from experiments, it is not possible to signal in this manner. In April, 1889, Mr. W. P. Johnston died, and the duties of electrician were entrusted to me. I resolved to change the class of signaling apparatus and to continue the experiment. Discarding continuous steady currents and polarized receiving relays, I adopted Cardew's vibrating sounder. I began from the beginning, and tried to signal across a waterway without a metallic conductor by laying down two earth-plates on each of its opposite banks. Readable signals having been exchanged, the distance separating each pair of plates was varied with the view of ascertaining how close the plates might be brought together, the signals still remaining readable. Readable signals were exchanged when the distance separating was equal to the breadth of the river, reading becoming more difficult as the plates were made to approach each other, and clearer and more distinct as the distance between the plates was made to exceed the breadth of the river. I learnt from these experiments that in order to obtain signals of sufficient distinctness for the practical purpose of transmitting messages, it would be necessary to construct a line on each bank of a river much longer than the breadth of the river; and as the rivers along the coasts in India are extremely wide, I became impressed with the impracticable character of such an undertaking, and decidedto strike out on a new line. This new line was the laying of two bare uninsulated iron wires across the waterway parallel to each other, and separated by a certain distance, the ends on each bank being looped together by means of an insulated conductor. Hence, though much of the circuit was laid under water, it was nevertheless a continuous metallic circuit. Beginning first with a complete square by laying the wires as many yards apart as the river was wide, signals were instantly exchanged that were incomparably louder than those that were exchanged when the same area was bounded by four earth-plates. The length of each of the two wires under water was next gradually increased to 740 yards, and the distance separating them gradually diminished to 35 yards, the strength of the signals diminishing proportionately, and ceasing to be readable when the wires were further prolonged. The conclusion arrived at from these experiments was that for the practical and useful purpose of signaling messages across a broad river in the absence of an insulated cable, a complete metallic circuit was at least desirable. Acting on this conclusion, it was sought to apply it practically, and the following experiment was carried out: At a distance of 15 miles west of Calcutta a cable is laid across the river Hooghly, which at this point is 900 yards wide. The iron guards of this cable were employed to form one of the metallic conductors, and at a distance of 450 yards down stream a single wire, weighing 900 lb. per mile, was laid across the river to form the second metallic conductor, insulated land wires having been run up to loop the two parallel conductors together. The experiment was quite a success, the signals being readable without difficulty.



Elec Engineer, N.Y.

SIGNALING ACROSS RIVERS IN INDIA.

The local line from the Central Office, Calcutta, to Garden Reach is about four miles in length, and at about midway the wire spans a small river. Vibrating sounders having been put in circuit at each end of this line, the wire where it crosses the river was taken down and laid along the bed of the waterway. Signals were loud and clear at both ends. From the success of this experiment it may be inferred that on any ordinary line, should the wire from accidental causes come off the insulator and make earth by touching the bracket, standard or ground, or should the wire break and both ends of it be lying on the ground or in a watercourse, communication could still be maintained by means of the vibrating sounders.

The line wire which connects the town of Chandernagore with Barrackpore is about 10¼ miles long, 900 yards of which consists of a cable laid across the river Hooghly. Vibrating sounders having been joined up in the telegraph offices at Barrackpore and Chandernagore, the insulated conductor of the cable was thrown out of circuit, and the line wire on each side of the river was joined to the iron guards of the cable; thus, for a length of half a mile out of 10¼ miles the conductor was wholly under water, yet it was found quite feasible to transmit messages between the two offices. From the success of this experiment it may be reasonably inferred that in the case of certain cable crossings where the rivers are not too wide, should the copper conductor of the cable make dead earth or become insulated by parting, communication could still be kept up between the two offices on either side.

Each of these three experiments may properly be described as a delicate experiment. With so much of the conductor under water, the quantity of current which reaches the receiving telephone is so infinitesimal that signals could not be successfully transmitted if the vibrator were joined up in the ordinary manner. It is desirable in circumstances similar to these to reduce all the resistance external to the actual connecting lines to as small a quantity as possible, and therefore, when messages are being transmitted, the telephone at the sending end should be removed from the circuit, as also should the vibrator from the receiving end.

To effect this two-fold purpose of a special form of signaling key, designed by the writer, is requisite and should be usen. The action of this key, together with the complete set of connections for a parallel cable crossing is shown in the accompanying diagram. The latter shows the connection for one end of the circuit, that at the other being identical in every respect.

DISTURBANCE OF TELEPHONE SERVICE BY ELECTRIC LIGHTING PLANTS.[1]

A short time since, the city of Bamberg, in Bavaria, erected a plant for lighting a limited portion of the city. The number of lamps used was but 24, these being connected by pairs in series, and fed by a 6-pole dynamo. The conductors of the circuit were separated from one another a distance varying from 15 to 100 metres.

When the above experimental plant was put in operation at the beginning of last December, there was noticed in the 60 telephone wires running across and between the electric light wires, a disturbing, buzzing noise, that interferred with the use of the instruments, and wholly prevented communication with the city of Nuremberg.

The telephone exchange was at a distance of but 130 metres from the dynamo station, and when one telephone after another was connected with wires of the disturbed district, the noise was found to increase with the distance. If two wires, in which the noise was equally loud, were connected together, the disturbance ceased and there was almost perfect quiet in the telephone. On the other hand the noise was greatest when a wire from the disturbed district was connected with one uninfluenced by the light wires. Although in two places the light wires crossed the telephone wires at a distance of two metres, yet the average distance of the two circuits from each other was 110 metres.

In the telephone circuit it was noticed that even when only a single pair of lamps situated at a considerable distance from the station were cut in, the noise in the telephone was quite perceptible.

The cause of this was, of course, the inductive effect of the lighting current due to the peculiar construction of the dynamo producing a variable current.

That the disturbance was principally caused by the direct inductive effect of the light wires, and only to a slight degree by leakage to earth, was shown by constructing a well insulated closed metallic telephone circuit whose return wire was not within the influence of the light wires. Even with this precaution the noise in the telephone was nearly as great as when the return wire was grounded. Further, when both wires of the lamp circuit were attached to the same pole, no disturbance was noticed in the telephones. This fact shows that, if in conformity with the requirement of the Royal Bavarian Telegraph Department, both light wires be placed on the same support, the indicated disturbance to the telephone service would be avoided.

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[1] Abstract of a paper read before the London Institution of Electrical Engineers, April 10, 1890.

[1] *Elektrotechnische Zeitschrift.*

The electrical engineering concern in Bamberg builds, besides the above named 6-pole dynamo, also 2 and 4-pole machines. In order to ascertain whether, or not, these last named dynamos would show the same inductive effects as the 6-pole machine, the following experiment was made: Connection was made between the city lamp circuit and a 2-pole dynamo in a neighboring factory. When now current was taken at a distantly removed pair of lamps, there was noticeable only a slight noise in the telephone circuit, but which in no wise interfered with the distinctness of conversation. Immediately thereafter currentwas taken from the 6-pole machine giving the current and at the same potential, and the loud noise was at once heard in the telephone.

Finally, in the same factory, by means of a special induction coil, a telephone circuit was subjected to the induction of currents from the several dynamos, and it was found that with the same current, only that from the 6-pole machine produced a buzzing noise in the telephone.

In regard to the insulation of the city light wires it was shown by measurement in damp weather to be only 800 to 2,000 ohms for the insulation resistance of the whole length.

Even this cannot be called favorable, yet the above shows that faulty insulation has no very great effect upon the telephone wires and that the disturbance can not be ascribed to this.

As a result of these experiments the authorities of Bamberg have taken steps to have more appropriate dynamos furnish current for the city lamps.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Kemmler's Respite.—The Edison Phonograph Sale Litigation.—The Electrical Inquests.—Awarding Contracts for Lighting.—Another Lecture by Dr. Wheeler.

One of the most interesting occurrences of the past week was the sudden stay of Kemmler's execution by electricity, through the intervention of Judge Wallace of the United States Circuit Court. Some of the newspapers that had made special and costly preparations have been in a fine state of frenzy since. and their furious attacks on the Westinghouse Company which they regard as the cause of their disappointment border on the farcical, so wild and melodramatic are they A bill is now passing through the Legislature abolishing capital punishment and there are even a few, who, sick and disgusted with the whole business, hope it may speedily be passed. The Westinghouse Company, it may be stated, denies most positively that it has had anything to do with the matter, or knows anything of the agencies at work on the bill abolishing capital punishment.

In the United States Circuit Court on May 2, Judge Wallace entered an order, after hearing the lawyers for both parties, allowing Thomas A. Edison to amend his bill of complaint against Ezra T. Gilliland and J. C. Tomlinson, to recover $175,000, which was a part of the purchase price paid by Jesse Lippincott for the Edison phonograph patents, to Gilliland and Tomlinson as Edison's agents, but, as Edison claims, not accounted for and paid to him by them as should have been done. The Court gives the defendants until June to file their answer. This order will, it is claimed, remove the objections which Judge Wallace recently found to the bill of complaint as originally drawn, and which he dwelt upon in his recent opinions, sustaining the demurrer of the defendants. Mr. Edison's lawyers hope, they say, to have the case finally presented for decision on its merits at the first term of the court after the summer vacation.

An inquest was held last week by Coroner Schultze in the case of Patrick Sullivan, who on December 14, last, was killed by an electric shock in the cellar of the Manhattan Electric Light Company's station, at Eightieth street and Avenue B. He went there to turn on the waste water pipe, and used a portable light. It was shown that the wire of the light was improperly insulated, and for this the jury censured the company, although there does not appear any good reason why the company would be blamed for a thing that the man himself was best able to see and be careful about,

As an offset to this it is encouraging to note that Supt. Pearce, who was indicted for manslaughter, in the case of the death of a clerk named Harris, who was shocked to death while holding a metal case that struck a low hung lamp, has been acquitted. There was no evidence to implicate Pearce, and it is satisfactory to note his acquittal, though of course, it is desirable that lamps should hereafter be so hung that no show case can thus strike them.

The Gas Commission has awarded a number of contracts for street gas lighting, but the controversy with the local electric lighting companies has not yet been settled.

Dr. S. S. Wheeler has again been called upon to lecture upon electricity before a Y. M. C. A. This time it was in Brooklyn, and the large audience was highly appreciative. The lecture ranged over the whole subject in a simple, easy manner, and was most happily and successfully illustrated by experiments and by the operation of ordinary every-day apparatus in such wise that all could "see how the thing worked." The Brooklyn *Citizen* devoted nearly a column to its report of the lecture.

New York, May 2, 1890.

PHILADELPHIA.

Long-Distance Telephone Subways.—An Inspecting Party from Boston.

Director Wagner, as presiding officer of the Board of Highway Supervisors, announced that the American Telegraph and Telephone Co. had distinctly and positively refused to repave over their conduits from the curb line to the railroad tracks on streets occupied by them by permission of Councils. In view of this fact the Director added that he had written to Superintendent Fairbanks, at the company's main office in New York, but without receiving an answer. "I wish to notify you now, gentlemen," said the director to his colleagues, "so that you may know how to deal with this corporation if it should at any time in the future apply for additional privileges. I think though that these people have obtained from us all that is in our power to grant." Chief Walker, of the Electrical Bureau, and Chief Bullock, of Highways, remarked that the trouble arose from some complication between the company and their contractors for street paving.

The Public Building Committee of the Common Council of the city of Boston, consisting of David F. Barry, chairman, and Edward E. Drew, Walter L. Hayes, Perlie A. Dyer, George E. Lovett, and assistant messenger Harry H. Osborne, arrived in this city on April 28. They came here to inspect the electric light plant in operation at the Public Buildings, with a view of adopting the system for the municipal buildings in their own city.

Philadelphia, May 2, 1890.

BOSTON.

Boston Electric Club.—Mr. Mansfield's Paper on Single and Double Trolley Wires.—Business Meeting.—Elevated Railway Legislation.—Permission for Increasing the Stock of the Boston Electric Light Company.—Metallic Circuits and High Tension Currents.—Boston Electric Company to Increase Their Lines.—Suburban Light and Power Company Refused by Board of Aldermen.—West End Street Railway Construction.

Mr. George W. Mansfield, well and favorably known as the engineer of the railway department of the Thomson-Houston Electric Company, read an interesting paper, (which we print more fully elsewhere.) before the members of the Boston Electric Club, on "Single and Double Trolley Systems." Mr. Mansfield is a strong advocate of the single trolley, and maintained from the beginning that it was the only practicable system. He pointed out the many obstacles there were in the way of double trolleys. The paper was listened to with much interest by all, and some discussion followed chiefly on the trouble caused to telephone lines by the induction from electric railway circuits. Mr. W. J. Denver, of the New England Telephone Company, made some interesting remarks relating to induction, and stated that the only cure he knew for induction was a perfect metallic circuit, but that that would require an outlay of a vast amount of money and a greatly increased number of wires; to give some subscribers lying in outlying districts a metallic circuit, would require, not the doubling of the number of wires, but in some cases would require five or seven times as many wires.

The next meeting of the club will be on Monday, when some important business matters will be discussed. Chief among them is a revision of the constitution and by-laws. The club is now entering upon a very successful period, and there are a large number of applications to be balloted for at the meeting on Monday.

The street railway committee has not yet come to any decision or made any special report as to the elevated railway question, and it is generally whispered that there will be lots of fighting before any decision can be arrived at.

The mercantile committee reported a bill to authorize the Boston Electric Light Co. to increase its capital stock to an amount not exceeding $2,000,000, making the entire amount $3,000,000. The new stock may be sold or issued from time to time in accordance with existing laws relating to the increase of capital of manufacturing corporations.

It was reported to the Legislature this week also that it was inexpedient to provide that electric companies shall use metallic return circuits, or to prohibit the use of electric currents of high intensity, The Board of Aldermen refused to grant permission to the Suburban Light and Power Company to erect 861 poles in Roxbury, Dorchester, West Roxbury and South Boston, but granted permission to the Boston Electric Light Company to erect 81 poles in Jamaica Plains and Boston. There will be a hearing on Monday on the petition of the Suburban Light and Power Company for a license to erect eight stationary steam engines of 1,000 aggregate horse power, at Hilton street, near East Chester park.

The West End Street Railway Company have commenced the work of relaying their tracks on Tremont street, starting at Dover street and working out towards Jamaica Plain. Work will soon be commenced on the overhead construction, and the new stations on Albany street and at Cambridge are rapidly progressing. The heavy foundation work at Albany street is now nearly completed, and the brick work is being started. It has been decided not to order any large amount of underground conduit or cable for the present, but several experimental lengths of various manufacture will be laid down at once in the yard, and careful tests made.

BOSTON, May 3, 1890.

CHICAGO.

Electrical Securities.—A New Washburn & Moen Plant.—The Electric Merchandise Company.

THE following prices were bid this week, on electrical stocks, at the Stock Exchange:

Central Union Telephone Co.	61½
Chicago Edison Co.	118

The stock of the Arc Light and Power Company is in strong demand. The company is paying 6 per cent., but it is earning between 10 and 12 per cent. The earnings in December were over 12 per cent. Last month they were about 11 per cent. It has been the policy of the company to put this surplus into extensions, so that the balance-sheet now shows the amount expended for property to be about $1,100,000, although the stock is only $1,000,000. Further additions will have to be made to the plant this summer, and it is probable that an issue of $100,000 of stock will be made at par to present holders. It is also likely that another $100,000 of stock, repesented by the extensions already paid for by surplus earnings, will be issued as a stock dividend. The directors have not formally passed on either of these matters yet, however. There is no disposition to increase the dividend rate, but rather to continue the policy to divert the surplus net earnings to build the extensions that are constantly called for.

The Washburn and Moen Wire Manufacturing Company, of Worcester, Mass., who have very extensive mills in that city, and turn out enormous quantities of wire, barb fencing and other specialties, have selected a large tract of land located in South Chicago, and will erect there an immense plant similar to the one in the East. Wharves, shops and cottages will be erected, and the company will reduce its own iron ores.

The Electric Merchandise Co. at Chicago has been incorporated with a capital stock of $50,000, to manufacture and lease machinery used in the construction of electric railroads. Incorporators, Cyrus Emery, John L. Ludwig and William R. Mason.

CHICAGO, May 3, 1890.

ST. LOUIS.

The Laclede Gas Company's Station.—Utilizing the Water Power of Grand Falls.—Electric Railway Work.

THE new electric station of the Laclede Gas Co. at the corner of Mound and Levee began supplying current for the alleys and city buildings north of Washington avenue on the 1st of April, and the temporary station at the corner of Franklin avenue and Second street has been abandoned and the machinery removed to the new station. This occupies a ground space 100 x 140. The boiler room, 40 x 100 and 30 feet high, contains 3 Heine safety boilers, each of 300 h. p., fitted with Roney automatic stokers, with coal and ash conveyers. There is spare room for five additional boilers. The engine and dynamo room, 100 x 100 feet, two stories in height, contains at present 2 Williams' high speed triple expansion engines, each of 250 h. p.

In the dynamo room—which is the second floor—are placed three 500 30 c. p. Heisler alternators, regulators and exciters, each supplying two circuits. Also two 1,000 16 c. p. and one 650 16 c. p. Brush alternators, exciters and switch-boards. The Heisler system is used for the alley lights, and the Brush system for lighting the city buildings. Four circuits are used in each system. The dynamos are driven direct from the engine shaft by means of the Siemens system of rope transmission, which, together with Hill clutches, was furnished by the Eclipse Wind Engine Co., of Beloit, Wis. The station will be supplied with water by a tunnel driven through solid rock from the engine room to the river, a distance of nearly 500 feet, which is now about ready for the final opening into the river.

The Joplin, Mo., Electric Light plant and the water power of Grand Falls of Shoal Creek have been purchased by an eastern syndicate for $55,000. The power of the falls, which is estimated at 5,000 h. p., is to be utilized by electrical transmission to the various zinc and lead mines in the vicinity. Thomson-Houston electric machinery will be used.

The South St. Louis Railroad have begun on relaying and wiring track, but, as yet, it is not known what system will be used. The Short system—double trolley parallel—after much delay, have received their regulating rheostats, and are now making trials of their motor cars.

ST. LOUIS, April 30, 1890.

PITTSBURGH.

The Michales Mining Machine Company.—Visiting Statesmen.—The Duquesne Traction Co.—New Electric Roads.

THE Michales Mining Machine Co. of this city, has decided to erect a factory at McKeesport, near here, for the purpose of going into the manufacture of these machines. This is the mining machine which has only recently been invented. It has been frequently tested in some of the mines in the Monongahela valley and proved to be thoroughly successful. It is operated with the Tesla alternating current motor of the Westinghouse Electric Co. The Mining Machine company intend to expend $100,000 in the establishment of their plant.

Among the many visitors, who come daily to view the Westinghouse electric works in this city, was not long ago a deputation from the town councils of Connersville, Ind., which is about to establish an electric light plant; and these men came here to examine the Pittsburgh electric light.

The Baltimore and Ohio Railroad Co. is going to light up all the stations between Pittsburgh and McKeesport with electric lights. The company is now putting up a plant at Glenwood, from which these stations will be lighted. The capacity of the plants is 120 arc lights and 500 incandescent.

The Duquesne Traction Company of this city has struck another snag which will involve that corporation in serious litigation. The residents of Hiland avenue, which is a part of the proposed route of the Duquesne road, have filed a bill in equity against the company, and it is hoped that by that means the Traction people will be prevented from laying their tracks on that thoroughfare. Hiland avenue is one of the most fashionable streets in the east end of the city. It has now an asphalt pavement and the residents fear that the road will greatly detract from the value of their property. The suit is based upon the ground that the Duquesne Traction Company, having secured its franchise by a special ordinance has really no right to lay its tracks on any street at all, because such rights can only be granted by a general ordinance.

Mr. J. M. Ferguson, a prominent capitalist of this city, is about to erect a building in Pittsburgh which will contain a very novel scheme for supplying power to the occupants. The building is to be erected to suit light manufacturing purposes. In the basement, a number of dynamos will be placed, which will generate electric power that is to be transmitted to a large number of motors distributed among the various manufacturing plants in the building. The structure will cost about two hundred thousand dollars and it is expected that it will be one of the finest in the city.

The Perry Street Railway Company of Allegheny city, has been chartered in Harrisburg, with a capital stock of $100,000. Another new street railway in Allegheny is the Bellevue Street Railway Company with a capital of $6,000. Both of these roads belong to the Pleasant Valley Electric Railway system.

PITTSBURGH, May 2, 1890.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter, previously inserted will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

LOSS BY HYSTERESIS.—A REPLY TO PROF. THOMSON.

[125.]—In your issue of April 9, in elucidation of certain remarks made by me at one of the meetings of the American Institute of Electrical Engineers, I have made some statements on hysteresis which Prof. Thomson has commented on in connection with his own views on the same subject, as expressed in your issue of April 30.

Prof. Thomson makes a quotation from my letter which shows that he has not properly understood some of my statements, and then goes on to say: "Mr. Tesla seems to forget that *loss*, *waste* and such terms are more scientifically rendered by the words "conversion into heat," * * and, "Now we may consistently amend his quoted statement, etc."

My statements were the outcome and, as it were, a continuation of a practical discussion, and I attached to the words used no philosophical meaning. By energy "wasted" I meant what probably everybody else except Prof. Thomson understood me to mean, namely, energy supplied to the core and not available for a useful purpose. Prof. Thomson states further: "Mr. Tesla seems to forget * * that in nature nothing is wasted or lost, but merely converted." But a little later *he* makes the remark, "The difference then between very soft iron and hard steel so far as *magnetic waste* goes, etc." Prof. Thomson also "seems to forget that *loss*, *waste* and such terms are more scientifically rendered by the words 'conversion into heat' and that in nature nothing is wasted or lost, but merely converted."

I most politely decline the "consistently" amended statement. If Prof. Thomson would have said, that *loss*, *waste* and such terms are more scientifically rendered by the word *conversion*, I would have agreed with him; but I cannot agree as to the expression conversion *into heat*. When on a bright, but cold, winter's day one steps into his office and finds no coal in the stove and switches on the current of a dynamo to a bank of incandescent lamps with the main object of warming up the room, then all the energy that appears as light is *waste;* or, if this distinction which I make is not made by Prof. Thomson, then I will cite the example of a thermo-dynamic engine in which, besides the *loss* in heat there are *losses* in chemical affinities, light, mechanical motion, electricity and magnetism. Everybody must admit that since Prof. Thomson wants to be so eminently scientific it is immaterial for the present consideration whether the *loss* amounts to one or a million units. This being so, I must confess that I fail to see the advantage of substituting for an unscientific but *correct* expression a scientific but *incorrect* one.

After *consistently amending* my statement he says: "Heat action is that swinging back and forth referred to, namely, 'molecular vibration' and if we find that such swinging takes place we must have heat as a result. When the molecules can polarize or turn without being given a swinging movement or vibration, no conversion into heat takes place." If Professor Thomson means to convey the idea that heat action is such a movement of the molecules, which is accompanied by a local displacement of the centres of the molecules, then, considering the existing uncertainty as to the character of *that* movement of the molecules which constitutes heat, he would do a valuable service to science if he would *prove* his view. There is hope that he will do so, for he says: "If we *find* that such movement takes place, etc.," whence I infer that he must have *observed* it. Then again, if we conceive a swinging or vibration without displacement of the centres of the molecules, such as the swinging or vibration of a magnetic needle, for instance—an improbable, but not impossible movement—according to Prof. Thomson, "no conversion into heat," would take place. Yet such movement would be a movement of material particles *in* or *through* matter, and would represent energy. If the movement be arrested in any manner, then the energy of this movement would be transferred or converted into another kind of movement or form of energy; and since Prof. Thomson says that it would not appear as heat, then in the sentence, "no conversion into heat takes place," the word "heat" ought to have been emphasized.

As to the statement, "When the molecules can polarize without being given a swinging movement or vibration," I must admit that with my weak intellectual powers I cannot perceive how in the world they *can* polarize without a swinging movement or vibration; but I can easily see that they can *be polarized* (for any length of time) without a swinging movement or vibration. However, Prof. Thomson may be able to explain.

Prof. Thomson further says: "Heat action is that swinging back and forth referred to, etc." The swinging back and forth referred to by me is that *assumed* angular and local displacement of the molecules which is directly produced by the reversals of the current in the coil energizing the core, and which may be effected, say, 250 times a second. Since, according to Prof. Thomson himself, not *any* movement but a *particular* movement or mode of motion of the molecules constitutes heat, then, instead of saying, "heat action is that swinging back and forth referred to, etc.," would it not be more correct to say that the energy of these comparatively few "back and forth" movements of the molecules is converted into heat by increasing the amplitude or number per unit of time, or both, of the original vibrations of the molecules?

After stating that, "when the molecules can polarize or turn without being given a swinging movement or vibration, no conversion into heat takes place," Prof. Thomson says: "In like manner, bending a bar of tempered steel back and forth within limits, is mechanically efficient, because *very little conversion of motion into heat takes place*, and this is a result of the *relative positions of the molecules being preserved*, etc." Then, after all, there is *some*, however small, conversion into heat, though, according to Prof. Thomson, there ought not to be *any*, since no swinging movement or vibration back and forth is imparted to the molecules, their relative positions being preserved.

Then comes the statement: "The difference between very soft iron and hard steel, so far as *magnetic waste* goes, is, apparently, that in the soft iron there is less disturbance of position of the molecules during magnetization and reversal than in steel, assuming the degree of magnetization or polarization to be equal in each." The italics are mine. While this *ex professo* assumption cannot be contradicted, yet it has very little in its favor, and is not in harmony with the views of the most competent scientists, who prefer to assume that the molecules of steel move with greater stiffness, or, in other words, that, for *the same disturbance of position*, more energy is required in hard steel. Maxwell has shown, theoretically, that in removing a permanently magnetized body to infinity from another magnet, the work done is twice as great as when removing to infinity the same body magnetized inductively to the same degree. Since a weakening and strengthening of the inducing magnet is equivalent to its removal, or approach, respectively, we can conclude from this consideration alone that the dissipation into heat will be the greater, the longer the molecules are capable of *retaining* the induced *magnetism*, and that under otherwise equal conditions the probable theoretical limit in hard steel will be reached when the dissipation is twice as great as that in wrought iron. Now this quality of retaining the induced magnetism *is* commonly attributed to the steel molecules. A graphical representation shows at a glance the importance of this lagging of induced magnetism, and makes it appear more probable that this quality of *retaining*, rather than the greater displacement of the molecules, is the cause of the greater dissipation in hard steel.

Prof. Thomson further states: "The *waste* or conversion due to electrical resistance is of the same nature." I hardly need point out the fallacy of this statement. The waste or conversion due to magnetic action is always proportionate to the number of the molecules of the magnetized body; the *waste* or conversion due to electrical resistance is not always proportionate to the number of the molecules of the conductor. Ether is an excellent conductor of magnetism, but may be a conductor, or perfect non-conductor, for an electric current, and the conditions determining this are unknown to us. From this alone it should be concluded that both conversions cannot be of the same nature. But an example will make it clear. Suppose we partly exhaust the air in a Geissler tube and pass an electric current through the air in the tube; then a certain resistance will be offered to the passage of the current and a certain amount of energy will be converted. Now, we may exhaust more air and at a certain point there will be an increase of resisttance. So we may go on until we reach any desired degree of rarefaction. The resistance and consequently the *waste* due to the same will continue to increase, yet the disturbance so far as the air molecules are concerned—since their number will be enormously reduced—will be continually diminishing in amount. Assume the vacuum to be reached, then the resistance may be assumed infinite; there would then be, in the sense of the statements of Prof. Thomson, *no* disturbance, namely no disturbance of the air molecules, since there are *none* in the tube; yet the *waste* may be anything.

On the other hand we know from theoretical considerations and practical results that the "magnetic waste," to quote Prof. Thomson, is, under otherwise equal conditions, strictly proportionate to the number of molecules of the magnetized body.

Then comes the statement: "Whenever the ether strain can be transmitted from molecule to molecule of the conductor without much disturbance of their positions or without causing a swinging out of position back and forth, the conductivity is great and the reverse is true for bad conductors." Since the conductivity is measured according to a common standard this statement must stand the test of relativity and then it seems to me to be so evidently erroneous that it hardly need be contradicted. If we pass a current through a carbon filament and bring it to incandescence we cause a certain disturbance of the molecules. If we pass *more* current we produce a *greater* disturbance in the filament; nevertheless the conductivity is *greater* in the latter case. Prof. Thomson "seems to forget" that the conductivity of a body is determined by two things, namely, the conductivity of the molecules *per se* and the conductivity of the intermolecular ether. Hence, in passing a current through a conductor we produce two disturbances—that of the molecules and that of the ether in the space between them; and all who understand the problem of efficient light conversion are trying hard to confine most of the disturbance which may be caused by whatever *is* electric current, or moving electric charge, to the ether. From this it is evident that in some cases we may produce a *greater* disturbance of the molecules of the conductor and yet have *greater* conductivity because of the relatively smaller disturbance of the ether, since the conductivity of the conductor, as a whole, is a function of both the conductivities of the molecules and of the ether. The more the ether disturbance is made preponderating, the more efficient will be the light conversion. These facts have evidently escaped the notice of Prof. Thomson. This statement, so far as it applies to bad conductors, is likewise contradicted by the behavior of a great number of bad conductors which become good conductors under certain conditions. If, in the previous statement, Prof. Thomson means not the integral sum of the disturbance of position of the molecules, but the amplitude of the disturbance, then I only need to cite the example of an incandescent metallic conductor to disprove the general truth of his statement.

Then again Prof. Thomson says : "There is then to my mind no more difficulty in understanding (conceiving?) that a conversion into heat may be produced magnetically than electrically, or mechanically." For one so particular in the use of terms as Prof. Thomson, the expression that a conversion into heat may be *produced*, is not a happy one. Conversion into heat may be *effected*, not *produced*.

What I have said above will also have a bearing on a later remark of Prof. Thomson : "It is in my view more legitimate to attribute the heating effects of Foucault currents and other currents to a general molecular friction or hysteresis of conduction, if we may use such a term, than to assume the production of molecular currents in the heating or conversion of magnetic hysteresis,"—in which he treats the question of hysteresis *homeopathically*, as it were. There occur in Prof. Thomson's lettter expressions like "transmission of ether strains," "reducible to a single effect," etc., and some other contradictions which I have no time to comment on, but which will be observed by the careful reader.

Prof. Thomson concludes with the truly philosophical statement that we neither need to assume, nor can we deny, the formation of molecular currents,—and the reader is no wiser than before.

Nothing, however ably said or written, is unapproachable to criticism. A slip of the tongue in an *extempore* discussion, or a slip of the pen in a hurried letter, can easily occur; but a fair minded critic will make allowance for this and will not fall into the faults of pedantry and cavilling. But if one, without cause, makes himself guilty of these faults he ought to be dealt with in a like manner. If one is exacting he ought to take care to be exact himself. The error of one who makes an incorrect statement is not nearly as great as that of him who attempts to point out the error, and is in error himself. But, above all, one so liable himself to mistake ought not to assume the role of tutorship.

NIKOLA TESLA.

NEW YORK CITY.

WORDS OF GREETING.

WITH its 100th number, issued on the 2d instant, THE ELECTRICAL ENGINEER of New York, became a weekly publication. The change, we are informed, was made necessary by the remarkable recent development of the electrical field, in which discoveries and inventions have multiplied so rapidly that a monthly digest and record, according to the original plan of the publishers, has become inadequate and at the same time unwieldy. Beginning with the new series, THE ELECTRICAL ENGINEER will be published by a corporation organized under that name, while the editorial department will be in charge of T. Commerford Martin and Joseph Wetzler. We regard our contemporary as one of the most admirable among American class-journals, and trust that it may long live to review for its readers the world's progress in theoretical and applied electricity.—*Roller Mill.*

AMERICAN electrical journalism promises some new and exciting developments in the near future. We have already announced that the late editors of the *Electrical World*, Mr. T. C. Martin and Mr. Joseph Wetzler, have somewhat abruptly left the paper they have been so long connected with, and have taken the position together as editors of our namesake, the New York ELECTRICAL ENGINEER. This week the larger paper briefly announces its change of editorship under the heading of "another step forward," so that although no details or explanation of the rupture have been divulged, it seems to be evident that somewhat strained relations have preceded the event. Other changes are also reported, Messrs. Colvin and Shaw having also left their positions and joined the retiring editors. The engagement is announced as editor-in-chief by the *Electrical World* of Dr. Louis Bell, a well-known professor of high reputation in electrical physics. Meanwhile the New York ELECTRICAL ENGINEER, hitherto a monthly certainly with the highest scientific flavor, but naturally less go ahead than its contemporaries, is to be transformed into a weekly, and it is to be expected that under the spirited direction of the new editors a keen rivalry will be established, in which, taking into consideration the immense scope of the vast continent over whose electrical progress they will keep watch, we wish them both heartily progress and success.—*London Electrical Engineer.*

THE HALIFAX AND BERMUDA CABLE.

Mr. Joseph Rippon, general manager of the Halifax and Bermuda Cable Co., has arrived at Bermuda, and has selected a landing place for the company's cable about one mile from Hamilton, Bermuda, at which place the office will be located. The steamer "Westmeath," chartered to lay the cable, leaves London in about 10 days, and it is expected that communication will be established between Halifax and Bermuda by the middle of June.

DEPTFORD.[1]

Further reports of the failure, past, present, or future, of the Deptford station continue to be rumored, and, we suppose, will until the station is entirely opened. As a matter of fact, the Deptford station is working now, and has been working practically every day since November last, supplying current for the Grosvenor circuit—at half pressure, but usually full current—Deptford working as a reserve to the Grosvenor plant. A second engine is now erected, and sundry small improvements are being introduced into the second dynamo before starting. The reports of the failure of the Ferranti mains are devoid of any foundation. Recently a length of main, consisting of some 30 or 40 lengths, and extending round the Deptford station, was tested with transformers up to 18,900 volts without failure. The mains are considered quite satisfactory, and tons of the lengths are being manufactured. Some miles are already laid along the route in different parts. Although more time has been taken than has been expected, yet it is sufficiently noteworthy that, with the exception of enclosing the mains to satisfy certain authorities, the work at Deptford has all been carried out as originally proposed and determined, and the engineers avow themselves thoroughly satisfied with the result both of the dynamos and the mains.

A DENIAL FROM MR. WESTINGHOUSE.

The following letter from Mr. George Westinghouse appeared in all the Sunday papers :

"The recent articles and editorials in the daily papers connecting the Westinghouse Electric Company with the efforts of Mr. Roger Sherman in the Kemmler case, and with the passage of the Curtis bill for the abolition of capital punishment, have caused a number of my personal friends to insist that it is my duty to make a public denial of these statements. I therefore desire to say in the most emphatic manner possible that neither I, nor the Westinghouse Electric Company, nor any person associated with me, has any connection, direct or indirect, with the habeas corpus proceedings instituted by Mr. Sherman in the Kemmler case, or with the effort to abolish capital punishment in this State by legislative enactment. I make this denial without any reservation of any character.

"If there are any electrical interests behind these movements it is not the Westinghouse Electric Company, but it is more likely to be those electrical companies who, in the hope of injuring the business of a rival, caused electric lighting dynamos of a particular manufacture to be adopted by the State for execution purposes, and now find that the agitation which they have instituted and kept alive is reacting against themselves."

INFLUENCE OF MAGNETIZATION ON ELECTRICAL CONDUCTIVITY.

The curious influence of magnetization on the electrical conductively of iron, nickel, and cobalt, has recently formed the subject of a research by M. Goldhammer. Plates of the different magnetic metals were placed parallel or perpendicular to the lines of force produced by a large electro magnet, and the resistance of them was measured by a Wheatstone bridge. For bismuth the percentage variation was found to be proportional to the square of the magnetizing force, and also to the square of the magnetization; since, for this metal, there is a constant ratio between the two. The greatest variation took place perpendicular to the lines. For nickel and cobalt the resistance increases in the direction of the lines, and decreases in the perpendicular direction, the variation being independent of the sign of H, the magnetizing force. The precentage variation tends rapidly to a maximum as H increases, and attains it sooner for cobalt than for nickel; and since the curve connecting the two is very much like the curve connecting H with the intensity of magnetization, the author assumes that the variation, as in the case of bismuth, is proportional to the sqare of the magnetization. M. Goldhammer concludes from his experiments, and from some due to M. Du Bois, that in a magnetic field the physical properties of metals undergo modifications dependent on the directions of the lines of force. If these alterations are reversed with the reversal of the lines they vary directly as the magnetic intensity, while, if they are unchanged by the reversal, they are proportional to the square of the magnetic intensity.

ELECTRIC TRAM-CARS IN BERLIN.

Negotiations are proceeding between the General Electric Co., of Berlin, and the principal local tram-way company, with a view to the introduction of electric traction on the latter's system. The first line to be worked is the portion called Friedrichstrasse-Kreuzberg, and operations will be commenced as soon as the Berlin Municipality has given its consent to the employment of electric tram-cars. Only half the number of cars on the line in question will be fitted electrically. The reason for this is because the cars are small, and two cars will be coupled together.

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[1] London *Electrical Engineer*.

LEGAL NOTES.

MUNICIPAL LIGHTING.

STATE OF OHIO EX. REL. HAMILTON GAS AND COKE CO. VS. CITY OF HAMILTON.

The case of the State ex. rel. Hamilton Gas and Coke Co. vs. City of Hamilton, recently decided by the Supreme Court of Ohio, is deserving of the attention of all those who are interested in municipal franchises.

The facts in the case, as stated in the majority opinion of the Court, are as follows:

The Hamilton Gas Light and Coke Company was organized and duly incorporated in the year 1855, under the general incorporation act of May 1, 1852, for the purpose of supplying gas for the lighting of the streets and public and private buildings in the city of Hamilton, Ohio. At the time of its organization, by virtue of the provisions of an ordinance of the city of Hamilton passed in the year 1855, there was granted to the company, and it thereafter had, the use of the streets of the city, for the purpose of laying gas-pipes and mains, and supplying gas to the city and its inhabitants, for the period of 20 years, to wit, until the year 1875. Since the year 1875 the city has used the gas of the company only in accordance with the terms of various contracts entered into between the city and the company, from time to time, the last of which contracts expired January 1, 1889; and since the last-named date there has been no contract existing between the parties; the city has declined to use the company's gas, and has provided other means for lighting its streets. For the purpose of manufacturing gas, the company erected gas-works, and laid gas-pipes and mains, to the probable extent of 30 miles, throughout the city, for the furnishing of gas for public and private consumption. It is conceded by the defendant that the company has complied with all the provisions of the law of Ohio relating to gas companies, and with all the ordinances in that behalf of the city of Hamilton, and is entitled to all the rights, privileges, and immunities secured to such companies by the laws of the State. The city of Hamilton is a municipal corporation organized under the laws of the State of Ohio, and had, at the last federal census, a population of 12,122, and a corporate area of about three square miles. On the 4th day of September, 1888, the city, by its council, on the petition of a large number of its inhabitants, duly passed an ordinance providing for the submission to the qualified voters of the question of issuing the city's bonds to the amount of $150,000, for the purpose of gas-works to be erected by the city. Legal notice having been given, the question was voted upon by the electors at the general election held on the 6th day of November, 1888, and resulted in 2,412 votes being cast for the issue of bonds, and 59 votes against such issue. Upon that decision of the electors, the city council, on the 20th day of November, 1888, adopted a resolution that it was deemed expedient, and for the public good to erect gas-works at the expense of the corporation. On the 18th of December, 1888, an ordinance was passed by the council providing for the issue of bonds, for the purpose of erecting such works by the city, to the extent of $150,000. The entire issue was sold for more than the par value thereof, and the proceeds of the sale were turned over to the city treasurer for the erection and completion of the proposed works. On the 7th day of May, 1889, trustees of the gas-works were appointed by the city council, who duly qualified, organized their board, and proceeded to the erection of the works, in accordance with the decision of the citizens and taxpayers of the city of Hamilton. The board of trustees so appointed purchased land for the erection thereon of the proposed gas-works, agreed upon plans and details for the construction of such works, entered into contracts for the furnishing of material and the performance of labor, paid large sums of money upon contracts for material furnished and labor performed, and, in the execution of contracts, gas-pipes were extensively laid in the streets of the city. The defendant alleges that the gas-works are being built by the city for the purpose of furnishing the public lighting to the city, and that no action has been taken towards furnishing gas for private consumption; but the defendant cannot say what action, if any, the city will in the future take towards furnishing gas for private consumption.

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Under these facts, and under the Ohio statutes, a majority of the Supreme Court found against the Gas Company, and decided practically that a gas company operating under a municipal franchise has no legal protection against competition by the municipality itself, although such competition should mean confiscation of the property of such gas company.

There was, however, a vigorous dissenting opinion by Judge Spear, some extracts from which follow:

This company was organized in 1855, under the act of May 1, 1852, "to create and regulate gas-light and water companies." Its purpose was to manufacture gas and furnish it for lighting the streets and public and private buildings in the city of Hamilton. This was a public purpose. Its accomplishment would benefit the city by enabling it to more effectually protect persons and property therein. In accepting the provisions of the laws then in force, the company, in consideration of the privilege granted, undertook to supply a public want. This duty it cannot avoid or shirk. Neglect of it, as we will presently see, would subject it to severe loss and possible deprivation of corporate existence. To avail itself of the rights and privileges conferred, and to enable it to perform the duty imposed, the company, under the authority and direction of the city of Hamilton, expended large sums of money in the construction of works and the laying of mains in the streets of the city, and the furnishing of facilities for the supply of gas to the city and its people, taking upon itself whatever risk of return upon the capital thus invested there might be in the venture. It undertook this work and assumed this risk in view of the law regarding gas companies, and the power of municipal corporations over them. The act referred to authorized the incorporation of such companies for the "purpose of supplying gas to light the streets and public and private buildings of the city," etc., the purpose to be specified in the certificate of incorporation, and, when incorporated, the companies were authorized to carry on the operations named in the certificate, without limitation as to time. They were to "have full power to manufacture and sell gas, and furnish such quantities of gas as may be required in the city * * * for public or private buildings, or for other purposes," and, in order to accomplish this, were given power to lay conductors for conducting gas through the streets, etc., with the consent of the municipal authorities. Amendments to the act gave to municipal corporations the power to regulate the price at which gas companies should furnish gas to the city and to private consumers, to fix the price for rent of meters, and to require them to lay pipes and light such streets as the council might direct. On failure to extend pipes as directed, the city could erect works and lay pipes for the supply of such streets and other streets not lighted. A neglect of the company to furnish gas to the citizens or other consumers of gas, in accordance with prices fixed by the council, would forfeit all its rights, and the city could then erect, or authorize any person to erect, works, and supply gas to the city and private consumers. Such, in brief, were the provisions of law on the subject at the time of the incorporation of this company. Under this law, so long as a company complied with every lawful requirement to the public and to private consumers, the public object of the statute was accomplished, and, if the construction I contend for be correct, the right of the company to furnish gas to the city and to private consumers therein remained unimpaired, and the city had no power to interfere with the company's chartered rights by entering into competition with the company while carrying out the purpose of its organization. It is not pretended that this company has, in any respect, failed in the performance of any lawful requirement.

* * * * * * * *

In effect the statute gave to this company the exclusive right, so long as it complied with every requirement of law, to supply gas to the city of Hamilton and its inhabitants. This right was upon condition of performance of the required service by the company, an object beneficial to the community, and was a grant of a franchise vested in the state. Based, as it was, upon abundant consideration, and there being competent parties and a lawful subject-matter, the transaction was, in all essential particulars, a contract between the state and the company; and if, as I claim, and think can be maintained, there was granted an exclusive right, any taking back by the state in the manner proposed would be a violation of that contract, and would result in the taking of private property without compensation. The extent to which such contract may be changed, under the constitutional power to alter or repeal, will be considered further on. By the act referred to the general assembly did not part with the police power and duty of protecting the public health, the public morals, and the public safety, and hence such contract was not in excess of the power of that body.

* * * * * * * *

The construction of the statute claimed by the city is not reasonable. It shocks the moral sense. To admit that the legislature, after having, by laws enacted prior to the organization of this company, held out to gas companies an inducement to invest large amounts of money in works and pipes for the purpose of establishing their business of furnishing "such quantities of gas as may be required," would, when the expenditure had been made on the faith of the power granted, by an amendment, give to municipal corporations the power to embark in the same business, to supply the same want, and thus place the property of gas companies wholly within the control of municipalities, acting on the caprice of city councils, or the impulsive vote of the people, is to presume a lack of good faith in matters of state which would be dishonorable between individuals. A statute ought not to receive a construction warranting such a conclusion, unless its terms are so direct and unambiguous as to admit of no other construction; and if to give the construction contended for would result in an interference with vested private rights, and cause the state to legislate back to itself the franchises, rights, and privileges which it had created, and thus destroy the corporeal property of the corporation without compensation, then such construction is not permissible, because it drives us to the conclusion that the statute is unconstitutional. Sinking Fund Cases, 99 U. S. 718. "A statute should not receive a construction which makes it conflict with the constitution, if a different interpretation is practicable." Burt *v.* Battle, 31 Ohio St. 116.

It seems to be feared that this gas company cannot be accorded the right given it by the statute under which it was organized to furnish the gas that may be required in the city of Hamilton, because to do so would be a violation of the clause of the constitution (section 2, art. 1) which forbids the legislature to grant special privileges that may not be altered, revoked or repealed, and because there would thus be created a monopoly. If this is seriously urged, the answer to it is that no special privilege or immunity is created, because all citizens in Ohio had equal right, under the law, to organize a corporation for the purpose of doing what, in the nature of things, only one organization could do, namely, supply the need of the city of Hamilton for gas; and no monopoly, in any objectionable sense, was or could be created, because the company was absolutely within the control of the city, as to the price of its commodity, and, in all essential particulars, in the conduct of its business with the public. It is not wise to be too easily disturbed by the cry of "special privileges" and "monopoly." Those terms became odious from the fact that in England, by law or by royal prerogative, letters patent to particular individuals were granted to conduct certain lines of business, or trade in certain commodities, to the exclusion of all others, which resulted in the restriction of production, the impairment of the quality of the article produced, the enhancement of prices, and the enrichment of the few and the impoverishment of the many, and it was to forever prevent such enactments that the section of the constitution referred to was ordained. But no such result, in either aspect, could possibly ensue in the case we are considering, and hence no valid objection on the ground urged exists. On the other hand the business of this company was a business of a public character, at least so far as supplying the needs of the city was concerned. It was a want which the state might directly, or through a proper agency, supply by contract. In principle the case is not essentially different from that where the state lets to a bidder, where but one appears, the right to erect some public work. The advantage, if any results, may extend over a longer time, and it may not; but, however that may be, all citizens having the means, have an equal right and opportunity to avail themselves of the advantage. In this case the state held out the inducement to all citizens to organize for the purpose of supplying a public want of municipal communities. The incorporators of the Hamilton Gas Light Company accepted the state's proposition as regards the city of Hamilton. No other citizens did accept it. The company then went forward, and, in all respects, performed the duty, complied with the law as it then was, and with all amendments as to its proper regulation which have since been enacted. With what grace can the state now say to it, "You must withdraw, and leave to another agency the performance of the duty we intrusted to you, and lose the value of the property you have acquired in performing that duty,—property which, from its nature, can neither be removed nor profitably applied to any other purpose?" And from a moral standpoint as well might the state, after it had contracted with a citizen to erect a public building, and after he had procured his material, constructed his machinery, and employed his labor, ignore its contract, purchase its own material, construct its own machinery, and proceed with the public work.

* * * * * * * * * * *

Nor would a judgment of ouster work injustice to the city, for, before the expenditure of any money or the incurring of any obligation on the part of the city, it was duly notified of the claims of the company, and that legal action would be taken to enforce them. It is not assumed that there is any vested right in the gas company to light the city of Hamilton. It was to furnish what gas might be required. So that, when gas is not longer required, the right ceases. The city may return to oil or gasoline, or adopt some newer agency, as electricity, and the people may refuse to burn gas; and of this the gas company cannot complain, because its rights are not invaded. That a time might come when gas would not be required was one of the risks the company assumed. But so long as the streets, public grounds and buildings of the city are to be lighted with gas the right of this gas company to do that lighting, it seems to me, cannot be lawfully denied. Of course it is subject to the control of the city in all the particulars specified in the statute under which it was organized, and in later statutes relating to regulation. Under such authority the power of the city to regulate is ample. This regulation, however, is confined to the carrying out of the purpose for which the company was organized. While it may regulate, it may not destroy. The contention of the city shocks the sentiment of common justice. It is opposed to the general policy of the national government, as shown by the decisions of its highest court, and the action of its executive officers, and to that of our own state. An instance is referred to by counsel. Turnpike companies and plank-road companies were authorized by statute, and many toll-roads were built in various parts of the state, with right to take toll from all travelers. When the state sought to resume the power granted, provision was made by statute (section 8,036, Rev. St.) by which the companies should be paid for their property, and commissioners of counties, where these roads were located, were authorized and required to purchase the property of such companies within the county, and to issue bonds for the payment of same. Under this act, as is stated, Butler county alone has paid over $40,000. In its action in this matter the state has been governed by the plainest principle of justice and fair dealing. The same principle applied to the city of Hamilton and the gas company would require that, if the city desires to engage in the gas business, it should undertake to avail itself of the power given in section 2,486, and endeavor to buy the works already in operation there."

ELECTRIC RAILWAY EARTH RETURN CIRCUIT.

THE EAST TENNESSEE TELEPHONE CO. VS. THE KNOXVILLE STREET RAILROAD CO.

HENRY R. GIBSON, *Chancellor.*

This is a suit brought by the telephone company to enjoin the railroad company from using the earth as a return electric circuit, and from interfering with the electrical condition of the air, to its injury.

The telephone company claims:

(1) That it has a grant from the city to erect poles and string wires in, over and along all the public streets and alleys of Knoxville;

(2) That it has such posts and wires, and is doing a telephone business;

(3) That the railroad company is about to use electricity as a motor, with the earth for a return circuit;

(4) That the telephone company is now using the earth for its return circuit;

(5) That both companies cannot so use the earth at the same time, as the telephone current is too delicate to contend with the railroad current;

(6) That the railroad company's wires are also liable so to affect the electricity in the telephone wires, or are liable so to charge the air with its electricity, as to interfere with the very delicate electrical currents used by the telephone company;

(7) And that the telephone company has a "vested right" to the "exclusive use" of the earth and the air as against every person using the same for electrical purposes to the detriment of its telephones.

For these reasons the telephone company has obtained a temporary injunction against the railroad company inhibiting the latter from using the single trolley system or any other system that uses the earth for a return circuit.

To this bill the railroad company has put in a sworn answer, setting up, among other defenses, the following:

(1) The ordinance under which the telephone company claims its rights does not vest in it any such rights as it claims.

(2) That what rights the ordinance does give are not the property of the telephone company.

(3) That the railroad company's electrical appliances will not injure the telephones.

(4) And that if they should, the injury can cheaply be remedied.

On this answer, the defendant moves the Court to dissolve the injunction.

On the hearing of this motion, the affidavits of many electrical experts have been read, much electrical literature has been offered, not a few judicial opinions have been cited, and most able and elaborate arguments have been made. The whole subject of electricity has been brought before the Court, including a miniature telephone plant and a miniature electric car and electric railroad, so that Menlo Park itself seemed, in miniature, before the Court. The main questions for determination presented by the pleadings are: 1st, were such rights as the telephone company claims conferred upon it by the city of Knoxville; 2d, if so, are they exclusive and monopolistic in their nature?

On examining the bill I find that the telephone company avers that on October 22, 1880, it was "granted the right and privilege to erect its poles in, over and along the public streets, alleys, lands, roads and public squares of the city, to string its wires thereon, and to use and operate the same for the purposes of telephonic and telegraphic communication;" and that relying on said franchise it has constructed a telephonic plant and is now operating the same.

This averment is the foundation of the telephone company's right and claim to relief; and the truth of this averment is doubly denied by the railroad company, which says that no such franchise was granted, and that what was granted was granted to the telephone *exchange* and not the telephone *company*. On examining the ordinance of the city I find it reads as follows: "Be it ordained, etc., that the privilege of erecting poles on the public streets and alleys of Knoxville be granted to the East Tennessee Telephone Exchange, and this privilege of erecting posts shall be confined to telephone exchange purposes exclusively. That the posts erected shall in no way interfere with the public travel along the streets, sidewalks and public alleys of the city. That nice posts, straight and smooth, be required, and that the same be in line with the outside edge of the curbing."

To an impartial mind this ordinance does not seem to "grant the right and privilege to erect poles in, over and along the public streets, alleys, lands, roads and public squares of the city." The ordinance confines the location of the poles to the streets and alleys, and says nothing whatever about "lands, roads and public squares;" nor does it say the poles may be erected "in, over and along the public streets, etc.;" it says "on" the streets and "in line with the outside edge of the curbing." Neither does the ordinance say a word about any right "to string wires" on said poles, or about "using and operating the same for the purposes of telephonic and telegraphic communication."

I mention these matters for the purpose of ascertaining what rights were granted by said ordinance—to measure their comprehensiveness. The bill claims practically unlimited rights to erect poles, string wires, and "use and operate the same" "in, over and along" all the "public streets, alleys, lands, roads and public squares" in the city; whereas, the ordinance merely gives the "Exchange," not the company, the "privilege of erecting poles on the public streets and alleys, ... this privilege to be confined to the telephone exchange purposes exclusively."

It must be remembered that the telephone company does not claim any particular right of way, or strip or piece of ground, or any particular streets or alleys, within the limits of Knoxville, for its earth circuit, but it claims the whole of the surface of the earth, and all that is beneath the surface of the earth, within the corporate limits, as its exclusive property for all the purposes of an earth circuit.

Now, if at the time this ordinance was passed, any one had suggested that this limited privilege of "erecting poles" gave the Telephone Exchange a right to use all the ground on which the city stood, public and private, as an easement to be used in place of wires, to complete its electrical circuit, he would, no doubt, have been regarded as a wilful distorter of language. But if, in addition, he had claimed that this meagre privilege of "erecting poles" not only gave the Telephone Exchange a right to use all the ground, public and private, within the corporate limits as its own, but the right to use it to the exclusion of all other electric companies from now to the ending of the world, he would have been regarded as a wicked exaggerator, if not a deliberate falsifier. And yet this is exactly what the telephone company claims in its bill.

I am unable so to construe this scant "*privilege* of erecting poles" as to make it "grant the right" to the exclusive use of every inch of ground within the corporate limits, for all the purposes of an earth circuit for electricity. Such a grant could never have been in the minds of the Mayor and Aldermen; and I am unable to find these exclusive rights and monopolistic powers condensed in five such harmless words as "the privilege of erecting poles."

The telephone company, however, does not content itself with literally claiming the exclusive use of the whole of the earth on which Knoxville is built for its return electrical currents, but it claims a monopoly of the whole air also, and insists that no other electrical company can string its wires in the near neighborhood of the telephone wires. And thus the simple privilege of "erecting poles" on the side of the streets of Knoxville is magnified into a grant of the exclusive right to all the earth and all the air within the corporate limits of Knoxville, for all electrical purposes, except telegraphing.

But it may be urged that the ordinance says that "this privilege of erecting poles shall be confined to telephone exchange purposes exclusively." So it does; but will it be contended that these words, which are rather words of limitation than of extension, give the telephone company the exclusive right to use every inch of Knoxville's ground and a superior right to all its air, as its private property for electrical purposes?

And thus it is, this once humble telephone company, that was given the bare privilege of "erecting poles" on the edge of the curbing, now comes forward, and, by virtue of those two talismanic words, claims the right to make the electric light companies, the electric railroad companies, and all other electric companies, for all time to come, keep their wires from communicating with any part of the ground on which the city stands or else pay it for the privilege of so doing. In a word, it claims a perpetual monopoly of the earth upon which the city is built for all the uses of an electrical circuit; and also claims a superior right to the air itself, for electrical purposes.

Ordinarily a person's strength consists of his physical power, but the telephone company's strength is sought to be derived from its weakness; it says that its electrical current is so weak that all strong currents greatly affect and impair its usefulness, and that, as a consequence, no company using a strong current can lawfully use the earth for a return circuit without its leave. If this contention be correct, then no electric company can ever use the underground on which Knoxville is built without the consent of the telephone company. It makes no difference what grand discoveries and inventions in the use of electricity may be made. Coal, wood, gas, steam and animal power may all be superseded by electrical devices, machines may be invented to heat and light all of our homes, do all of our cooking, propel all of our vehicles and machinery, and all or a large part of this electricity may be drawn from the earth, or it may be drawn from the air, and yet Knoxville and her people are to be denied all of these wonderful benefits for all the ages to come, if they, either through the earth or through the air, in any way cripple or injure the feeble current of the telephone company, unless the telephone company gives or sells its consent.

The streets of Knoxville are held in trust by the city for the benefit of the people, to the end that the people may have the right to walk and ride and transport goods and animals, and propel vehicles over and along them. And the city has no right to allow the streets to be used for any purpose inconsistent with these rights of travel and transportation. Telephone poles have no connection with travel or transportation, and have no just rights on our streets, and are, at best, mere tenants at will. These doctrines were distinctly recognized by the city when it granted this privilege of "erecting poles," the ordinance emphatically providing that "the posts erected shall in no way interfere with the public travel." It may be said the trouble grows not out of the "posts" but out of the "wires." To this it is answered that the word "wire" is not in the ordinance, and all the right the telephone company has to use wires is as an incident to the post, and what the ordinance means is that neither the posts nor the wires on them shall, in any way, interfere with the public travel. In other words, this privilege of "erecting poles" or posts, is to be, in every respect, subordinate to the use of the streets, for public travel. If this be the meaning of the ordinance, then the city has the right to allow electricity to be used as a motor for the propulsion of street cars, and if the telephone poles or wires "interfere with the public travel" on these electric cars, the city has a right to have them removed. And, on this ground, also, it will thus be seen that instead of the telephone company having exclusive and monopolistic rights both to the earth and to the air for electrical purposes, it is a mere humble occupant of the streets, by permission of the city, and liable to be declared a nuisance whenever its poles or wires interfere with the public travel.

Fast, indeed, must our rights be slipping from us, and most insecure, indeed, must be their moorings, when such claims as these are countenanced by the courts. I have, heretofore, declared in a suit between the defendant and the city, that our streets are public property under the trusteeship of the Mayor and Aldermen, and very slowly and very reluctantly will I ever decide that any of the property of the people has become the fee of any one person, whether such person be a Kentucky corporation or one native born.

I might go further and show that there is no evidence or allegation that the E. T. Telephone Company, a corporation under the laws of Kentucky, is the E. T. Telephone Exchange that acquired this privilege of "erecting poles." The answer denies their identity, and the ordinance supports the answer. In the light of the present claims of this telephone company to the benefit of this ordinance, and to the monopoly of ground on which the city stands, for all the purposes of an earth circuit, I can only say that if such was its object when it secured the apparently humble privilege of "erecting poles," it was seeking to perpetrate a fraud upon the city of Knoxville, whose Mayor and Aldermen could not have supposed that they were selling the birthrights of their constituents for less even than a mess of pottage. The courts must see to it that no public grants, and no privileges granted, shall so be construed as to deprive the people of any rights or powers except such as are expressly stated or necessarily implied. In applying this rule I hold that the ordinance referred to did not give the telephone company any such exclusive right as it claims; and I am further of the opinion that under its charter powers, and under the corporation ordinance, the Knoxville Street Railroad Company has the right to propel its cars by the single trolley electric system, or by any other the city has authorized or may authorize.

TELEPHONED CONTRACT.

PADDOCK-HAWLEY IRON CO. VS. A. PULLIS ET AL.

This was a suit for $572.34, in a contract made by telephone. The plaintiffs received judgment, when a motion for new trial was made by the defendant. Judge Valliant, of St. Louis, in overruling the subject, said:

"Contracts by telephone," says the Court, "when proven, are as binding as any other contract; but the practical difficulty lies in the uncertainty of the proof, and this uncertainty is chiefly on the point of identifying the person with whom the witness held the telephonic communication.

"When a message by telephone has been received, there are many circumstances which may indicate who the person is that has spoken. But while some of these circumstances have been shown, there is no proof as to who the person is. It has, for example, been held that testimony of a witness to the effect that he was in the habit daily of having communications by telephone with a practical person, knew the number of the telephone and recognized the voice of the person, was evidence tending to prove the identity of the person who was in that case alleged to have made the contract. In this case at bar the defendant's testimony was to the effect merely that he called by telephone a number and asked who it was, and the answer came back that it was the Paddock-Hawley Iron Company. Prices were discussed, but no attempt was made to identify the person at the telephone who made the contract. Even if there had been no testimony to the contrary, this would not have been sufficient to justify the conclusion that it was the plaintiff.

"It has never been held, as far as I am aware," continues the Court, "that a telephone message merely purporting to come from a certain party, but with no evidence of identification, was binding on such party.

"In this case, however, the evidence on part of the plaintiff was positive to the effect that there were but two men connected with the plaintiff's concern who had authority to make such contracts, and that neither of them ever heard of this telephone communication until after the controversy arose. By rules of evidence applicable to this case the plaintiff is entitled to recover, and motion for new trial overruled."

ALTERNATING CURRENT LITIGATION.

GANZ & CO. VS. THE EDISON ELECTRIC LIGHT CO.

A remarkable complaint was filed in the United States Circuit Court this city on May 3, entitled "Ganz & Co., Eisengiesserei und Maschinenfabriksactiengesellschaft in Ofen, against the Edison Electric Light Company." Ganz & Co. have their headquarters at Buda-Pesth, Hungary, and own the system for distributing electricity by means of alternating currents of high tension, known as the Zipernowsky-Deri-Blathy system.

The complaint of Ganz & Co alleges that in 1886 an agreement was made with the old Edison Electric Light Company whose obligations have been assumed by the present company, by which the Edison Company was to introduce the system into the United States, and that $5,000 was paid the complainant on account of the agreement.

Ganz & Co. now allege they have discovered that the representations made to them when they transferred the system were false and fraudulent, and their object was to prevent the introduction of the system here. Endeavors have been made, it is further alleged, to create the impression that the alternating current is deadly and unfit for commercial use, and to bring such currents and systems into disrepute.

The complaint prays that Ganz & Co. may be released from the agreement and awarded proper damages.

ELECTRICITY AS A MANUFACTURED ARTICLE.

COMMONWEALTH OF PENNSYLVANIA VS. PHILA. ELEC. LIGHTING CO. ET AL.

At Harrisburg, Pa., Judge Simonton handed down two opinions last Wednesday in the Commonwealth cases against the Philadelphia Electric Lighting Company and the Brush Electric Light Company of the same city. Both of these companies claim to be manufacturing concerns, and as such, exempt from taxation under the recent act taking the tax off from manufacturing companies. The opinions discuss at great length the means by which electricity and electric light are produced, and quote extensively from the testimony of Professor Henry Morton, President of the Stevens Institute of Technology, whose testimony as an electrical expert was taken in these cases.

But Judge Simonton adheres to his opinion reached in a similar case about a year ago, that producing electric light is not a species of manufacture. He held that neither electricity nor electric light was a material substance; that there could be no manufacture unless some material substance was produced. It is expected that these cases will be argued in the Supreme Court on appeal at its meeting in June. In these cases a great deal of evidence was taken to show the unequal operation of the present tax laws upon different corporations. The lack of uniformity, it was claimed, made the tax unconstitutional. Judge Simonton, however, sustains the constitutionality of the tax except as to the amount involved on patent rights granted by the United States, which he holds are not subject to taxation. Upon this point the Attorney General may possibly appeal. The full amount of the Commonwealth's claim against the Philadelphia Electric Lighting Company is allowed, with interests and cost; but in the case of the Brush Company the amount is largely reduced by the decision as to the invalidity of the tax on patent rights.

OBITUARY.

Daniel L. Gibbens.

Daniel L. Gibbens, formerly one of the Subway Commissioners, died in this city on May 2 of pneumonia. A week ago Thursday he was a guest of Assemblyman Frederick S. Gibbs. Just before retiring he sat in front of an open window talking with Mr. Gibbs, who warned him of the danger of sitting in a draught. Mr. Gibbens said he did not take cold easily. The next day he was laid up with a cold and chills. Last Wednesday pneumonia set in. Mr. Gibbens was born in Waltham, Mass., thirty-one years ago, graduated from Columbia College and Law School, and in 1879 became teacher in a school at Boston, of which his father, E. A. Gibbens, was principal. He afterward became private tutor to the son of Roswell P. Flower, and upon the death of young Flower, private secretary to the father, who was then in Congress. In 1882 when Mr. Flower was in the race for the nomination for Governor, Mr. Gibbens was a prominent figure in Syracuse, and managed Mr. Flower's headquarters. He was also in charge of Mr. Flower's headquarters in Chicago in 1884. Mr. Gibbens had been studying law with more or less ardor all this time, and was appointed counsel to the Subway Board when Mr. Flower was a Subway Commissioner. When Mr. Flower resigned this place in 1886 he recommended Mr. Gibbens as his successor, and Gov. Hill appointed him. Mr. Gibbens became the leading spirit of the Board, and his encounters with Mayor Hewitt furnished a number of lively incidents until Mr. Hewitt declined to sit any longer with the Board. About three months ago Mr. Gibbens resigned his office, and since that time he has been the junior member of the law firm of Kennison, Crain, Alling & Gibbens. He had kept up his connection with electrical interests to the last. His remains will be removed to his mother's house at Fordham, where the funeral will be on May 5. The interment will be in the family plot in Boston, where Mr. Gibbens's father was buried six weeks ago.

Major Otto E. Michaelis.

Major Otto E. Michaelis, formerly Commander at the Watervliet arsenal, New York, died on May 1, at the United States arsenal in Augusta, Me., where he had been Commander for nearly three years. A few months ago he was promoted to the rank of Major, although only 46 years old. At the breaking out of the war he enlisted in the Twenty-third New York, serving three months, and then entering the signal corps as Second Lieutenant. Afterward he was transferred to the ordnance corps. In 1864 he was promoted to First Lieutenant, and in 1874 to Captain. He was the first private citizen to pass a successful examination for this service. For ten years, from 1875 to 1885, the Major served in the West with Gen. Terry and Gen. Miles, being on the former's staff, and being chief ordnance officer in the department of Columbia and Dakota. He was also at different times stationed at Frankfort, Waterford, and Watervliet arsenals. He was an expert in engineering and electrical matters, being one of the founders and Vice-President of the American Institute of Electrical Engineers, of which he was a most valued officer, taking the keenest interest in its welfare and prosperity. He was a broad man, of many tastes and sympathies. He was an expert and an authority on whist and chess, and was a member of the Manhattan Chess Club and the Engineers' Club of this city. In 1857, when only fifteen years of age, he played a series of games at chess with Paul Morphy, the famous player, at the St. Nicholas Hotel. Michaelis had the odds of one rook and won two games.

The death of Major Michaelis is directly due to the physical and mental shock sustained by the drowning of two of his children at Augusta, during the past winter, when he made desperate efforts to save them, and was himself rescued with great difficulty from the broken ice.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 29, 1890.

Alarms and Signals:—*Electrical Signaling Apparatus*, J. U. Mackenzie, 426,621. *Electric Fire-Alarm*, C. H. Shaffer, 426,688. *Fire-Alarm Telegraph System*, John Speicher and F. T. Fearey, 426,691. *Circuit Closing Hinge for Electric Burglar Alarms*, W. F. Bleakley, 426,705. *Burglar Alarm*, J. H. Bleoo, 426,706. *Thermostatic Circuit-Closer*, W. H. Chambers, 426,917. *Electrical Tell-Tale Device*, E. F. Roberts, 427,014.

Distribution:—*Potential Controlling Device*, W. Stanley, Jr., 426,573. *Regulation of Electric Motors*, W. Stanley, Jr., 426,574.

Dynamos and Motors:—*Brush and Holder for Electrical Machines*, 426,471. *Regulation of Dynamos and Motors*, W. T. Peel, 426,570. *Dynamo Electric Machine*, J. Wenstrom, 426,576. *Regulator for Dynamos*, J. J. Wood, 426,699.

Galvanic Batteries:—*Galvanic Battery*, F. Gendron, 426,932.

Measurement:—*Device for Measuring Electrical Currents*, T. H. Hicks, 426,499. *Electrical Measuring Instrument*, M. M. Garver, 426,992 and 427,022.

Metallurgical:—*Apparatus for Producing Sheets of Metal by Electro-Deposition*, M. G. Farmer, 426,788. *Electrolytic Apparatus for Forming Copper Ingots*, M. G. Farmer, 426,789.

Miscellaneous:—*Electric Heater*, C. W. Drew and E. R. Francis, 426,437. *Automatic Determining Device for Phonographs*, T. A. Edison, 426,527. *Induction Coil*, A. M. Frankenberg, 426,563. *Switch Apparatus*, M. M. Davis, 426,583. *Electrical Fuse*, H. Tirmann, 426,971. *Circuit-Closer*, H. B. Whitaker, 427,024.

Lamps and Appurtenances:—*Apparatus for Manufacturing Electric Light Carbons*, H. A. Tremaine, 426,479. *Electric Lamp Post*, W. Carroll, 426,660.

Railways and Appliances:—*Electrical Train Signal*, G. D. Burton, 426,522. *Electric Railway*, E. M. Bentley, 426,580. *Electric Engine*, R. W. Thompson, 426,650. *Electric Motor Car*, J. A. Brill, 426,657 and 426,658. *Electric Railway Car*, J. A. Brill, 426,708. *Electric Refrigerating Apparatus for Railway Cars*, M. W. Dewey, 426,781.

Secondary Batteries:—*Method of Making Electrodes for Secondary Batteries*, G. E. Heyl, 426,724.

Telegraphs:—*Message-Recording Instrument*, J. C. Wilson, 426,554 and 426,555. *Quadruplex Telegraphy*, F. W. Jones, 426,591. *Automatic Telegraph*, F. Anderson, 426,749. *Duplex and Quadruplex Telegraph*, F. W. Jones, 426,819. *Telegraph Key*, O. Kleber, 426,941. *Apparatus for Electrical Communication*, J. L. Cutler, 426,989.

Telephones and Apparatus:—*Tablet for Telephones and Clamp Attachment for the same*, J. B. Morris, 426,462.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

THE "NATIONAL ELECTRIC" LIGHTING SYSTEM.

It is understood that the National Electric Manufacturing Company, of Eau Claire, Wis., will soon be represented in the East by a concern to be known as the National Electric Construction Company, which will be well officered and have ample capital. The system is already finding a foothold. The Hotel Normandie, in Washington, will soon be lighted entirely with electricity, and the plant, consisting of one 600-light and one 300-light direct current machines, is furnished by the National Company. The Schaefer 100 volt 16 c. p. lamp will be used. The installation is being made by Mr. L. N. Cox. The machines will be run by two Beck engines. Mr. Cox also reports the installation, recently, of a 250-light plant in the machine shops of Messrs. Dietrick & Harvey, of Baltimore, Md., for the same company.

THE INTERIOR CONDUIT AND INSULATION COMPANY.

The above-named company is rapidly getting into shape to meet the enormous business that has begun to develop in its specialties. Although the factory has been enlarged almost from week to week to keep pace with the demand for the "interior" tubes for wiring, it cannot arrest the accumulation of orders, and it has become necessary to run night and day on this class of work alone. In the meantime, the merits of the tube for underground work have been perceived, and another illimitable field has thus of a sudden opened up. A single order for this underground tubing last week ran over half a million feet, and that was simply a "starter." As an advance in lightness and simplicity the "interior conduit" for underground operations, compared with many older methods, is like the American buggy, compared with the solid, cumbrous English coach; and the cost of such work is reduced to the narrowest minimum. The company has now found it desirable, for the dispatch of business, to have all its executive officers together, and has secured handsome quarters on the second floor of the Western Union building, 16 and 18 Broad street. There a fine suite is being laid out in a tasteful and comfortable manner. The general offices will be under the charge of Messrs. Willard and Little, and President Johnson will occupy a spacious private apartment adjoining. The company has, in fact, already taken possession of these quarters, and the present week will find it at the very height of activity at both ends of the line.

THE WENSTROM CONSOLIDATED DYNAMO AND MOTOR COMPANY.

This Company, recently organized in the city of Baltimore, with E. L. Tunis, president, and Messrs. Enoch Pratt, D. D. Mallory, Robert Rennert, General F. C. Latrobe, Governor E. E. Jackson and Ex-Governor James B. Groome as directors, with a capital stock of $1,000,000, for the purpose of manufacturing and selling dynamos and motors, for street car and other purposes, and doing a general electrical business, having purchased the patent rights of Jonas Wenstrom, of Orebro, Sweden, for his dynamos and motors, for the United States, announces that it is in the market "without fear of competition. These machines have been made in the shops of our predecessors during the last twelve months. A number of them have been put in actual operation and in every case have not only given entire satisfaction, but have far exceeded anything claimed even by ourselves, extravagant as it may appear at first glance."

The Company call attention to a number of testimonials, as well as to the Judges' report (Messrs. F. B. Crocker, C. O. Mailloux, O. A. Moses, J. G. Case and A. A. Knudson) at the American Institute Fair, in 1889; and to the series of tests made by the Electrical Testing Bureau at Johns Hopkins University.

RUBBER GLOVES FOR LINEMEN.

High potentials demand good insulation, and it is now thoroughly recognized that it pays in more ways than one to put the circuits in such a condition that they will withstand all the ordinary assaults of the wind and the weather. But occasions arise when it becomes necessary for linemen to handle open or leaky circuits of considerable voltage, and then no matter how excellent the line wire may be, it is extremely desirable that the men should be properly insulated also. It might seem that this is a mere truism, but truisms in this knowing modern world of ours generally go for less than they are worth; and it must be confessed that the lineman, with his own consent and indifference, has but too often been the victim of neglect in this respect. We are glad, therefore, to see that the Metropolitan Rubber Company, of 649-651 Broadway, this city, is now making a specialty of rubber gloves for linemen. These gloves are somewhat different from the usual make, containing as they do the strictly best grades of rubber, so as to be absolutely non-conductive, and being manufactured with double thicknesses in the parts most exposed to contact. Thus, with superior material in special quantity, they combine unusual flexibility, and are not cumbrous to wear.

These gloves are as cheap as kid, and are now being used by many of the principal companies, among whom may be mentioned the Buffalo, N. Y., Brush Company, the Manhattan Electric Light Company, the United States Illuminating Company, and the Brush Electric Light Company, of New York city. We could heartily wish that every local company running high potential circuits would furnish these gloves to its employees. The item of expense would be infinitesimal, while the insurance secured would be of enormous value. Moreover, we opine that such gloves would have their use in all factories building high potential apparatus.

ALBAMURAL.

Mr. William D. Warner, of 135 Pearl street, Boston, is introducing to superintendents of electric light stations, and to manufacturers in general a new form of *fire-proof* paint, called "Albamural," which is attracting a good deal of attention. Some such paint has long been a felt want, and whitewash, kalsomine, and similar materials have all been tried with varying unsatisfactory results. They nearly all rub off or flake off in time, and soon become very dingy. If oil paint is used, it is impossible to make it fire-proof. "Albamural" comes to the front as a solution of the difficulty, and anyone using it once will be sure to use it always. It is a superior wall coating, giving a smooth, glossy finish, that will not flake, or rub off, is easily applied to any surface, and is much cheaper than paint, kalsomine, and kindred materials. It is the whitest thing ever known, which is largely in its favor where a good light is required. Nearly the entire mixture is composed of a material absolutely fire-proof, thus making it a great fire retardent. Although less than a year since its first appearance in a crude way, on this market, there is now a brisk demand for it. A company with abundant capital has been formed for its manufacture, and the supply will be equal to the demand.

THE WAINWRIGHT MANUFACTURING CO. OF MASS.

The Wainwright Manufacturing Company have sold a 300 h. p. heater to the Wilmington City Railway Company, Wilmington, Del., and a 150 horse power heater to John Post, Jr. & Co., for shipment to Fall River. The Wainwright Mfg. Co., of Mass., is a new corporation, organized in 1889, under Massachusetts laws. Capital, $100,000, with the following officers: Jno. Abbott, President; John A. Loring, Vice-President; Geo. D. Hall, Jr., Treasurer and Manager; Bicknell Hall, Assistant Manager; John F. Fife, Superintendent, and F. H. Lovejoy, Sales Manager. This Company succeeded the Wainwright Co., of Medford, Mass., and continues the manufacture of surface condensers, feed-water heaters, separators, Harvard pump regulators, expansion joints, corrugated copper and brass tubing, besides doing a general foundry and machine business.

The general office and works are situated at Medford, Mass., five miles from Boston, on the western division of the Boston & Maine Railroad, located on the south side of the Mystic River, covering several acres of land, with eight hundred feet of sea wall front, enabling 300-ton vessels to discharge coal, iron and coke into the yard, very close to the foundry.

The buildings consist of a main office, foundry, machine-shop, corrugation-shop, erecting-shop, pattern-shop, blacksmith-shop, stable, rumbling and chipping sheds, besides store sheds for supply and finished work, and is the largest heater and condenser works in the world. Owing to the rush of orders, an electric plant has been installed, in order to work nights.

THE AUTOMATIC FIRE ALARM AND EXTINGUISHER CO. LT'D.

This company have removed their general offices, 294 Broadway, where they have been located since 1875, to 413 Broadway, where they now occupy four floors, divided up into the various executive, central office, store, rooms, shops, etc. They have similar plants and equipments in Boston, Philadelphia, etc. S. G. Babcock is president; E. O. Richards, secretary; and J. P. Curtis, treasurer.

THE FORT WAYNE SLATTERY ALTERNATING SYSTEM.

The Fort Wayne Electric Company have prepared and issued the following list of the largest Slattery induction plants put in by them:

Brainard, Minn., Light and Power Co., 600 lights; Beaumont, Tex., Ice, Light and Refrigerator Co., 600 lights; Central Electric Light Co., Chicago, Ill., 4,000 lights; New Glasgow, N. S., Electric Co., 600 lights; Consumers' Gas Co., Danville, Pa., 600 lights; Electric Improvement Co., San Francisco, Cal., 6,600 lights; Eau Claire, Wis., Brush Electric Co., 1,000 lights; Jenney Electric Light and Power Co., Fort Wayne, Ind., 1,000 lights; Galena, Ill., Electric Light Co, 600 lights; Grinnell, Ia., Electric Light Co., 600 lights; Manhattan Electric Light Co., New York City, 21,000 lights; Citizens' Electric Light and Power Co., Houston, Texas, 2,000 lights; Halifax, N. S., Gas Light Co., 1,950 lights; Lebanon, O., Light, Heat, Fuel and Power Co., 600 lights; Fargo, Dak., Incandescent Light Co., 600 lights; Madison, Wis., Electric Co., 1,000 lights; Queen City Electric Light and Power Co, Dallas, Texas, 2,000 lights; Ruch Bros., Columbia City, Ind., 600 lights; Saginaw, Mich., Electric Light and Power Co., 1,000 lights; Swift & Co., Kansas City, Mo., 600 lights; Swift & Co., So. Omaha, Neb., 600 lights; Swift & Co., Chicago, Ill., 2,000 lights; M. W. Simons, Plymouth, Ind., 1,000 lights; Utica, N. Y., Electric Light Co., 3,000 lights; L. D. Cardwell, Harrodsburg, Ky., 600 lights; New Iberia, La., Electric Light and Power Co., 600 lights; Pittsburg, Kan., Gas Light and Power Co., 600 lights; Allen Apartment Building, Chicago, Ill., 600 lights; Feeble Minded Institute, Fort Wayne, Ind., 600 lights; Northwest Electric Construction and Supply Co., St. Paul, Minn., 2,000 lights; Jenney Electric Light and Power Co., Pekin, Ill., 600 lights; Detroit, Mich. Electric Light and Power Co., 5,600 lights; Citizens' Electric Light and Power Co., East St. Louis, Ill., 600 lights; City of Ironton, O., 2,000 lights; Middletown, N. Y., Electric Light Co., 1,650 lights; Wyandotte, Mich., Electric Light Co., 600 lights; Waterhouse Electric Co., Baltimore, Md., 2,000 lights; Stellar Electric Co., Boston, Mass., 1,000 lights; Woodstock, Ont., Electric Light, Power and Railway Co., 650 lights; Port Hope, Ont., Electric Light and Power Co., 650 lights; Bloomington, Ill., Electric Light Co., 1,000 lights; Champion Electric Co., Springfield, O., 1,000 lights; Thomson-Houston Electric Light Co., Charleston, Ill., 600 lights; Kingston, N. Y., Electric Light Co., 2,000 lights; Excelsior Electric Co., Harrisburg, Pa., 2,600 lights; Fort Wayne Electric Co., Evansville, Ind., 1,000 lights; Northern Indiana Prison, Michigan City, Ind., 1,200 lights; North New York Lighting Co., N. Y., 600 lights; St. Clair Steam Supply and Electric Light Co., Belleville, Ill., 1,000 lights; Decatur, Ill., Electric Street Railway Co., 600 lights; Louisiana Electric and Power Co., New Orleans, La., 7,000 lights; Stockton, Cal., Gas Light and Heat Co., 1,000 lights; City of Galion, O., 800 lights; Lowville, N. Y., Electric Light and Power Co., 650 lights; Yonkers, N. Y., Schuyler Electric Co., 1,000 lights; Jersey City, N. J., Electric Light Co., 3,000 lights; Armour Packing Co., Kansas City, Mo., 1,200 lights; Manhattan, Kan., Electric Light Co., 650 lights; Electric Improvement Co., San Jose, Cal., 1,000 lights; Jenney Electric Light and Power Co., Logansport, Ind., 600 lights; Leetonia, O., Electric Light and Power Co., 600 lights; Cincinnati, O., Electric Light Co., 3,000 lights; Corporation of Collingwood, Ont, 650 lights; Brockville, Ont., Incandescent Electric Light Co., 1,000 lights; Stroudsburg, Pa., Electric Light and Power Co., 650 lights; Haddonfield, N. J., Electric Light Co., 1,300 lights; Saratoga, N. Y., Gas and Electric Light Co., 650 lights; Bridgeport, O., Electric Light and Power Co., 650 lights.

SAWYER-MAN LAMPS.

The Queen City Electric Light Company, of Gadsden, Ala., in a letter of April 26 to the Sawyer-Man Electric Company, says :—

"We have something wonderful in the way of an incandescent lamp to report to you. On July 4th, 1888, we started our incandescent dynamo. Among the lamps in the station was one over the engine, which has been running all night long every night since and is still running now. Counting from July, 1888 to July, 1889, we have 365 days, and from July 4th, 1889, to May 1st, 1890, we have 300 days more, which together makes 665 days of 12 hours=7,980 hours. No doubt some will discredit this statement, but nevertheless it is true. The above described lamp is a Sawyer-Man 16 c. p. 110 voltage."

R. A. KELLOND.

Mr. R. A. Kellond has opened offices at rooms 27 and 28, No. 63 Broadway, and will there carry on a patent soliciting agency, with branches in Montreal and Washington. Mr. Kellond has an intimate familiarity with Canadian as well as American patent practice, and is well equipped in every way for his work. He has already made a specialty of electrical work, and has had several important cases in hand.

CROCKER-WHEELER ELECTRIC MOTOR COMPANY.

Mr. T. McCoubray, secretary and general agent, has issued the following notice :—"To meet the extraordinary demand for our motors, we have removed to the building bounded by Washington, 13th and 14th streets, New York. We have been compelled heretofore, to ask indulgence in billing orders. With our vastly increased facilities, we are now able to handle all business promptly. We solicit your orders, and invite correspondence on electrical engineering subjects."

The Company's perfected motors are meeting with very pronounced success, and a large number of them are already in operation on the various systems all over the country.

CHADBOURNE, HAZELTON & CO.

Chadbourne, Hazelton & Co., formerly general agents of the Sprague Co. for Pennsylvania, Maryland, Delaware and Southern New Jersey, having severed that connection, have now completed arrangements with the Wenstrom Consolidated Dynamo and Motor Co. of Baltimore as sole selling agents for the United States.

The Equitable Electric Railway Construction Co., A. H. Chadbourne, president, W. Hazelton, 3d, secretary and treasurer, and W. A. Stadelman, chief engineer, will continue to transact as heretofore their general construction business for railways, isolated plants, etc., for both lighting and power purposes.

The offices of the concerns above named are at 416-18-20 Walnut street, Philadelphia, and the warerooms are at 28 South Fourth street.

THE MASON PRIMARY BATTERY.

Mr. J. H. Mason, of 63 Broadway, is lighting the library of Prof. Ives' house at Rockville, Conn., with two of his 20 c. p. lamps, using 14 of his No. 11 cell. The room is 18 x 20 feet, and is well lighted by this means.

Mr. Mason has been appointed sole agent for the electrical department of the Kato Manufacturing Company of Jersey City, who make a specialty of portable lamp ware.

ENGLISH, MORSE & CO.

English, Morse & Co., Engineers of Kansas City, Mo., report recent sales of power plants as follows: Pittsburg Gas Co., Kan., one 125 h. p. "Ideal" engine; Boonville Electric Light Co., of Boonville, Mo., one 80 h. p. "Ideal" engine, with steel boiler and complete plant; Abernathy Furniture Co., K. C., Mo., one 30 h. p. "Ideal"; engine, with boiler, dynamo, motor and complete plant; Girard Electric Light Co., Girard, Kan., one 60 h. p. steel boiler. Also numerous orders for Lahman-Kirkwood rocking grates, "Leather Link" belting, Hill clutch pulleys, Worthington steam pumps, etc., etc.

WESTINGHOUSE LIGHTING APPARATUS.

The Westinghouse alternating current arc light system is growing in popular favor very rapidly. The company is constantly in receipt of complimentary letters which testify to the many advantages of the system, and the productive capacity of the Pittsburgh works is tested to its very utmost. Of late, many inquiries have been made for a smaller dynamo than the ordinary sixty light machine. To meet this demand, the company is now manufacturing a small 25 light dynamo of a unique and very pleasing design. The Westinghouse alternating current arc light apparatus has been contracted for during the month of April by electric light companies at the following central station plants : Troy, N. Y., 60 ; Saratoga, N. Y., 60 ; Salt Lake City, Utah, 25 ; Evanston, Ill., 120 ; Joliet, Ill., 60 ; Martins Ferry, O., 40 ; Uxbridge, Mass., 60 ; Oxford, Ohio, 60.

During the month of April, the Westinghouse Electric Co. sold its alternate current incandescent apparatus for central station electric lighting plants in the following places : Portsmouth, Va., 1,500 lights ; Saratoga, N. Y., increase, 1,500 ; Salt Lake City, Utah, 500 ; Mt. Morris, N. Y., 500 ; Brookline, Mass., 900, increase ; Johnstown, N. Y., 500, increase ; Springfield, Mass., 3,000 increase ; St. Thomas, Ontario, 750 ; Ouray, Col., 750 ; Sherman, Texas, 750 ; Detroit, Mich., 6,000 ; Susquehanna, Pa., 750 ; Elmira, N. Y., 750 inc.

THE GARVIN MACHINE COMPANY.

The Garvin Machine Co., of Laight and Canal streets, N. Y., has recently issued a very complete and well printed, illustrated catalogue of its machinery and machinists' tools of all kinds. It would be hard to name any tool required in an electrical factory or station that is not therein described and shown by excellent wood-cut or outline sketch. The line of milling machines we note to be very large, no fewer than 16 different patterns and sizes being included. The department of screw machines is also remarkably ample, and not less may be said of the drill presses, tapping machines, etc. The section relating to gear cutters is also specially noteworthy. The company invite correspondence, and have a well deserved reputation for care and exactitude in meeting all the conditions and requirements imposed by the highest practice and principles.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

Geo. M. Phelps, President. F. R. Colvin, Treas. and Business Manager.

Edited by
T. Commerford Martin and Joseph Wetzler.

New England Editor and Manager, A. C. Shaw, Room 70—620 Atlantic Avenue, Boston, Mass.

Western Manager, W. F. Collins, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada,	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* The Electrical Engineer. *Communications for the attention of the editors should be addressed*, Editor of The Electrical Engineer, 150 *Broadway. New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

Vol. IX. NEW YORK, MAY 14, 1890. No. 106

What is the truth, is the goal of intellectual mankind in all ages, and its pursuit leads not only to intellectual but also to physical satisfaction.—Prof. Henry A. Rowland.

THERMO-MAGNETIC GENERATORS.

THE economical production of electric energy direct from medium, heat without the employment of a secondary such as a prime mover, has led many to search in the direction of the thermo-pile for the solution of the problem; and not a few are at the present time occupied in this field. The recent investigations into the thermo-magnetic properties of iron have, however, somewhat turned the tide of the work of electrical inventors, some of the most prominent of whom have recently given their attention to the thermo-magnetic generator and motor, among them being Mr. Edison and Mr. Berliner. To these must now be added Mr. Tesla, a little of whose work in this field, though accomplished several years since, we are now enabled to publish for the first time. It is evident, from the description on another page, that Mr. Tesla early recognized the cardinal principles to be observed in order to obtain the maximum efficiency of which motors of this class are capable, and the arrangements which he adopted for that purpose are well calculated to attain the objects desired. The criticism has been truly made that thermo-magnetic motors can, at best, be but comparatively inefficient converters of energy, on account of the small range of temperature through which the heated medium is worked; and the inventor has recognized this fact by the rather anomalous employment of steam as a cooling medium, which, after having performed this function and absorbed additional heat, may be employed for other useful purposes. Though no commercially practicable thermo-magnetic apparatus has yet been forthcoming, it is not too much to hope that, with the progress already made, a machine of commercial value may be looked for at no distant date.

REPORTS ON THE PARIS EXPOSITION.

Although much has been said and written on the electrical work displayed at the recent Paris Exposition, no systematic attempt has, so far, been made to co ordinate the various exhibits and to subject them to a critical analytical treatment. The material available for such a work was quite ample and well worthy of consideration, and our readers will therefore be pleased with the information embodied in the report of Mr. Carl Hering, who was one of the American Jurors of Awards of the Electrical Section of the Exposition. The first section of Mr. Hering's report which we print in this issue contains a complete summary of the exhibits of electrical conductors, both bare and insulated, and presents a good résumé of the state of the art at the present day. It is gratifying to note that notwithstanding the youth of the art in this country, American insulated wires, as a rule, carried off prizes. The figures relating to the various bare conductors of high tensile strength manufactured in France are worthy of the attention of our manufacturers.

BOSTON MEETING OF THE ELECTRICAL ENGINEERS.

After a lapse of six years, the American Institute of Electrical Engineers is again to hold an annual meeting outside New York. When the meeting was held in Philadelphia in 1884 at the Electrical Exhibition, the society had but just been formed and the membership was small. To-day it shows all the signs of growth, prosperity and usefulness, and the mere fact that in New England alone it now has nearly as many members as it had all told in 1884, promises a large attendance in Boston next week. We print elsewhere the excellent programme submitted by Mr. R. W. Pope, the secretary, and are glad to see so large a list of good topics to be treated by well-known engineers. A subject that will doubtless be taken up, is that of "American electrical units," and one or two interesting committee reports may probably be looked for also. There is, moreover, much to be seen of electrical interest in Boston, and the Electric Club emphasizes its hospitality with a dinner and a paper on one of the most important questions of the day. Altogether, the Institute's Boston meeting should be most pleasant and profitable.

THE PRICE OF COAL AND THE TARIFF.

In the past a considerable part of the advantage possessed by European manufacturers in competition with those of the United States has lain in their cheaper coal. The changed conditions of coal supply have now, for the most part, reversed the situation in that regard, the advantage now lying on this side of the Atlantic. While the price of coal has been advancing in Europe, it has been greatly diminished in America during the past ten years, mainly through the discovery and opening up of large deposits of semi-bituminous coal in the middle and southern states. This coal has well nigh superseded anthracite as a steam coal; and, judging from the columns of the coal trade journals, a further indefinite increase of the supply may be counted upon. $4.75 per ton may fairly be taken as the price of steam coal in New York in 1880. It is now reported from $2.75 to $3.50—sales averaging at between $3.00 and $3.10. A sale of 60,000 tons at $2.75 to a railway company is said to have been made recently.

Meantime prices have so advanced in Europe that the export of coal to the Continent has been contemplated by large operators here as a feasible outlet for the excessive production in this country.

A valued correspondent, conducting a factory at Antwerp, informs us, under date of April 11, that the finest steam coal, *briquettes*, had advanced 60 per cent. in price since a year ago, while common steam coal had risen fully 100 per cent. Prices at Antwerp, early in April, reduced to dollars and cents and to gross tons, were as follows: Anthracite, $5.77; Briquettes (best form of steam coal) $4.93; common steam coal, $4.43. While so extreme an advance may not be fully maintained, it is quite certain that this country will henceforth possess a distinct and considerable advantage in the price of fuel for manufacturing purposes. Its high cost in Europe must seriously modify the conditions of manufacturing there, and effect a dislocation of trade.

Now American manufacturers can reap the full benefit of their cheaper coal, and take their legitimate position in competition with Europe in the markets of South and Central America, Australia, Asia and Africa, only by standing on an equal footing in other respects.

Free raw materials are obviously the first and most pressing requisite to clear the path of our manufacturers and exporters. The most intelligent and far-seeing of them have demanded the removal of duties on the materials of manufacture in no uncertain voice. The condition of coal supply accentuates their position and adds another argument to the many sufficient ones already adduced in support of it.

It is hardly conceivable that the McKinley view, to wit: that foreign trade is a bad thing to have, will for any length of time be taken seriously by American citizens. They will not indefinitely neglect their advantages and opportunities.

Graphic Demonstration of Electric Potential.

To students whose grasp of mathematical conceptions is limited, the fundamental ideas regarding the nature of what is termed electric potential, are apt to be a stumbling block which seriously interferes with progress in some of the most interesting branches of the science. A graphical explanation of the nature of electric potential based on its defined properties will, therefore, go far towards opening the way to a clear understanding of the notion embodied in electrical "potential." Prof. Mayer's elegant demonstration given on another page proves by a well known analogy that the curve expressing the work done in approaching two bodies charged at a given potential, is quite analogous to that made by the steam engine indicator, being of the nature of an hyperbola.

Electric Motors vs. Steam Locomotives.

Mr. J. C. Henry contributes to our columns this week a very interesting and suggestive article on some of the points of difference between electric locomotives and steam locomotives. This subject is not nearly so much one of the future as many people suppose, but is one that is already being freely discussed from a variety of practical standpoints. Electrical engineers realize that when they have done as much in perfecting the electric locomotive as mechanical engineers have done upon the steam locomotive, they will have something to be proud of. Meanwhile they are at work, and will be heard from. Mr. O. T. Crosby will, it is understood, contribute a most valuable paper on the limitations of steam and electricity in "teletravel," at the Boston meeting of the American Institute of Electrical Engineers next week.

Dr. Lodge's Lightning Arrester.

In several of our recent issues we have described new forms of lightning arresters, embodying very ingenious construction, in which one of the principal objects aimed at was the avoidance of all inductive resistance which might offer an obstruction to the passage of the lightning discharge. But as again illustrating the great flexibility of the principles of electricity in practical application, our readers will note elsewhere an arrangement designed for this purpose by Dr. Oliver J. Lodge, in which coils of high self-induction are employed for the purpose of *compelling* the discharge to jump the air gap. This construction adopted by Dr. Lodge is a logical sequence of his "alternative path" experiments which deservedly attracted so much attention at the time. These experiments, it will be remembered, were carried out in a great variety of forms, and some surprising results were obtained. It may be of interest to recall the fact that Faraday also observed and described the phenomenon which has been so well elaborated and utilized by Dr. Lodge.

Primary Battery Combinations.

Given a certain number of substances available as active and depolarizing materials in a primary battery, a very simple calculation will show the number of combinations that can be effected in this direction. The variety resulting from the calculation is, however, so large, that, though probably hundreds of combinations have been tried, there still remain a large number for experiment. And that there is still virgin soil open to cultivation is evidenced by the description of a new battery to which Prof. A. E. Dolbear drew attention in our last issue. The high electromotive force obtained is quite remarkable and is no doubt due to employment of an alkali as the active electrolyte in combination with the powerful acid depolarizer. It is barely possible, also, that the difference of potential created between the alkaline and acid solutions themselves may aid in raising the E. M. F. to the points observed. There can be but little doubt that more than one of the many waste products, especially of chemical manufactories, could be usefully applied in batteries. We have but recently been advised of another striking example of this and shall probably soon be able to give fuller details.

ELECTRIC MOTORS VS. STEAM LOCOMOTIVES.

BY JOHN C. HENRY.

In a recently published paper by Dr. Louis Bell on the subject of electric railways the popular opinion that steam locomotives are wasteful engines is in a measure combatted by reported tests and comparisons. I can cannot help thinking that Dr. Bell's conclusions are erroneous in this respect, and will give some reasons for this opinion.

I have no wish to disparage the work of the engineers who developed the locomotive. To me they move to-day as living monuments to nameless thousands of students and mechanics whose limbs have failed and whose brains have been worn out in their efforts to improve this almost human machine. Did it ever occur to to the reader to estimate at what cost the locomotive of to-day has been developed? Consider the thousands of lives that have been lost in railroad accidents, each of which developed perhaps a single fact that a certain portion of the machine was faulty or weak, or that metal of a certain shape or in a certain position would deteriorate rapidly, that one portion was too heavy, and another too light.

Is it any wonder that the novice who carries his wooden model into the presence of the railroad official usually finds that gentleman averse to changes, and apparently disinterested, or "cranky," and retires with the opinion that no one outside of the "ring" can have his devices or improvements adopted. Every country section has such working individuals; add to these vast numbers the thousands employed with the locomotive, all with the chief aim as their greatest desire to improve and surpass their fellows, would the estimate that the present development of the locomotive had cost 100,000 lives be unreasonable? I think not.

Such considerations raise the question, Is it worth the price? If the Emperor of China's objection to the introduction of the Steam Horse in his domains are based on any such considerations, it is not wholly without reason; but science knows no sentiment. Our present existence and future welfare depend upon the husbanding of energy. The time will come when it will all be exhausted, whether physical, mental or mechanical. With the latter I will attempt to deal. The point I wish to prove is that notwithstanding this immense cost and the improvements suggested by nearly seventy years' experience, the popular locomotive of to-day is an unscientific, extravagant machine, and that on the points of economy, ease of manipulation and safety, it cannot compare with the new-born electric motor, and is distanced by the stationary engine.

To deal with the subject properly, comparisons must be made and weaknesses pointed out. Stationary engines have automatic cut-offs; locomotives depend upon manually operated ones, which are necessarily intermittent and much less sensitive to varying conditions than a spring would be to a changing load. Poor regulation means a waste of steam. Stationary engines have balanced valves; the steam pressure against them is equalized and they consequently move freely. Locomotives, owing to their peculiar construction, require the valves to be on top of the cylinders, which precludes the use of anything but slide valves, which have the full weight of the steam pressure bearing against their movement. Owing to the compact requirements, locomotive boilers have much less heating surface than stationary boilers; this necessitates the use of a forced draught, which means that the larger portion of the heat passes out of the stack, the boiler absorbing the most intense heat only. Stationary boilers are usually covered with several courses of brick to confine the heat. This would be impracticable on a locomotive; they are usually covered with thin wood lagging, the detrimental effects from which in varying temperatures are great. I have frequently seen locomotives lose steam at the rate of about a pound per second when passing through snowdrifts. The loss of fuel is very considerable in bad weather or when running against the cold winds.

I question the correctness of the reported tests in Dr. Bell's paper; they seem as unreasonable as some I once made with an electric motor. It appeared to show an efficiency of 115 per cent. I have carefully watched the tests of some of the finest locomotives in the West. The best result I have ever known was a consumption of 8 lbs. of coal to the h. p. hour, and this was under the most favorable conditions. The same locomotive showed a consumption of over 20 lbs. of coal to the h. p. hour when working "down in the corner."

In the absence of other accurate data on this subject which I expected from the article referred to I investigated the startling economical reports of the performance of the Elevated Railway locomotives. I found they consumed from 50 to 90 lbs. of anthracite coal per mile, run with five coaches. Striking the average at 70 lbs., and estimating the average weight of the trains at 250,000 lbs. to move this weight 100 miles would require an expenditure of but 276 h. p. hours; dividing this into the amount of fuel actually consumed would show a consumption of 25 lbs. of coal to the h. p. hour. This estimate is based upon a perfectly level track in good condition and no stops. The extra amount of energy lost in ascending grades is partially regained on the descent, and a certain proportion is lost by the car brakes. Some years ago Mr. Frank J. Sprague carefully investigated these losses, and, I think, placed them at about 40 per cent. of the total, which seems to be fair; this would leave the result that the New York Elevated Railway locomotives consumed, on the average, about 15 lbs. of coal to the h. p. developed per hawes. We all know that stationary engines are on the market that will not consume over one-fifth of this amount of fuel for the same power developed.

There is very much to be said in favor of the rotary movement of electric motors as opposed to the reciprocating steam engines. I am told that Mathias Baldwin, founder of the celebrated locomotive works, had the idea haunting him throughout his life, that the locomotive should have rotary engines. "Appleton's Applied Mechanics," under the head of "Steam Engines," has the following: "It has been said that there is scarcely an engineer of much experience who has not designed at least one rotary engine." The tendency of everything is to rotation; this is exhibited so prominently in nature and art that—pardon the thought—it may be the coming man will rotate.

In locomotives it has been found impracticable to put them in running balance. Suppose we were to support one on its frame, leaving the drivers free to revolve, and, then open the throttle; the locomotive would immediately commence a rocking motion, and the tendency to leave the foundation would increase as the square of the speed.

Some years ago, Mr. McLoud, engineer of tests of the Pennsylvania Railroad Co., investigated this evil effect, and calculated that one of their latest designs of locomotives, when running at full speed, was delivering trip-hammer blows at each revolution of the drivers equal to the force of 60 tons. Among thoughtful railroad engineers the opinion was pretty general that the horrible Ashtabula Bridge railroad accident which caused about 80 deaths and 60 wounded was primarily due to this unscientific construction which is still in the steam locomotive, but absent in the electric motor.

ELECTRICITY AS A "BUG" DESTROYER.

BY FOREE BAIN.

The Electrical Engineer of April 30, contained editorial comment on an article in the *Manufacturers' Record* in regard to catching bugs, moths, birds, etc., by the use of the electric arc light. Please allow me to make a suggestion by relating an incident that occurred in the early days of the electric lighting industry.

In the fall of 1879 I put five Maxim 5,000 c. p. arc lights in the gardens at the Highland House, Cincinnati. The first few nights they went as well as could be expected, and everybody seemed pleased. Finally, one day after the lights had been in place only a short time, the circuit was inadvertently reversed and the lamps burned "upside down" for one night. That night all the elite of the city were on the Hill, but they did not remain long. The heavens were beautifully illuminated by the lights, and this attracted more bugs than people. The globes of the lamp became full of bugs in a short time. Then began the process of boiling and cooking bugs, and this I can assure the readers of the ENGINEER was not pleasant to the olfactory organs. It was estimated that at least one ton of bugs had perished that night by their folly in "tackling" the electric light.

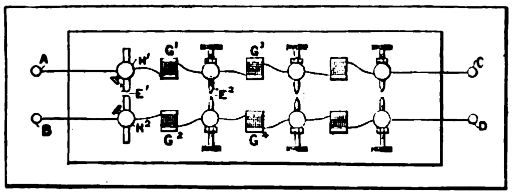
It seems to me that in the article I have referred to above, there is a disposition to encourage the use of electricity as a kind of "Mothaline," or "Rough on Rats." I therefore fall in on the popular side, and suggest that, if electric light people desire to do any catching of moths or "bugs," they reverse the lamps. They will get all they want.

DR. LODGE'S LIGHTNING PROTECTOR.

THE very interesting series of experiments on the "alternative path" made by Dr. Oliver J. Lodge, have recently been applied by him to the construction of a lightning arrester, and, in general, as a safeguard against high tension currents. In these experiments, it will be remembered, a static discharge was found to prefer to jump an air space in preference to passing through a straight conductor of very low resistance. The explanation given for the phenomenon is that the self-induction or electro-magnetic inertia of the conductor offers a virtual resistance to the sudden passage of a current, greater than that of the air gaps, which is consequently jumped.

In applying this principle Dr. Lodge has still further increased the resistance to the passage of the charge through the metallic conductors by making them in the shape of coils having a high self-induction.

One form of the new arrester is shown in the accompanying engraving.[1] Here A and B are the terminals inserted in the leads, or A is connected with the line wire and B with earth; C D are terminals connected with the instrument to be protected, or C with the instrument and D with the earth, or C with the instrument and D left insulated as desired. E^1, E^2, etc., are air-gaps or insulating spaces; G^1, G^3, etc., are self-induction coils, consisting of gutta percha covered wire coiled up on bobbins.



DR. LODGE'S LIGHTNING ARRESTER.

The action of the arrangement is as follows: The ordinary currents, which it is intended to transmit through the apparatus to be protected, traverse the connecting wires or self-induction coils, G^1, G^3, etc., and do not jump any of the air-gaps. But lightning, or any other foreign and violent currents which may accidentally have got into the leads, will jump one or more of the series of air-gaps, and be thus diverted from the instruments or lamps to be protected.

Thus the insulating spaces or air-gaps may be arranged so that the greater portion of a violent discharge will jump the first, E^1; a certain fraction, say a tenth of the remainder, will jump the second, E^2, and so on; the amount finally permitted to go through the protected instrument being thus reduced to any desired amount.

According to Dr. Lodge it may be well to set the air-gaps or insulating spaces of different widths; for instance, the first having broad, rounded ends wider apart than the second, exposing larger surface and capable of easy examination and replacement in case of damage by a flash; the second having small rounded ends or points close together, and capable of minute adjustment by screwing up with lock-nuts, the third still closer and finer. It may also be well to vary the connecting coils, using thicker and more highly-insulated wire for the earlier coils, and thinner for the latter.

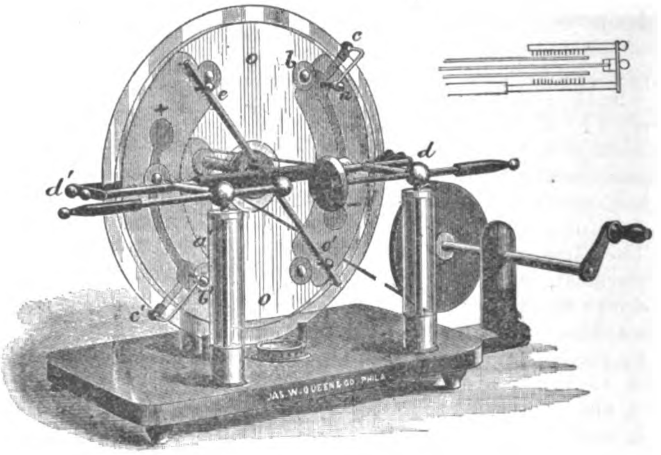
THE ACTION OF THE TOEPLER-HOLTZ MACHINE.

BY PROF. MARSHALL HENSHAW, AMHERST COLLEGE.

In a leaflet recently issued by Messrs. Queen & Co. there appears a proposed explanation of the action of the Toepler-Holtz machine, which, it seems to me, is hardly satisfactory. The explanation given is identical with that of Mr. Eaton published in *Science* in 1884. This journal at about the same time also published an explanation which differs materially from the one cited.

As neither of them is satisfactory to some, I submit the following as appearing to me simple and adequate, using the language of the two-fluid hypothesis, which we are obliged to employ for the want of a better.

It must be borne in mind that induction never takes place *on*, but *through* a non-conductor. The dielectric may be a single substance or many. In this machine, as seen in the illustration, it consists of two plates of glass and two of air. The initial action is the friction between the brushes and the buttons. Let *a* be the brush on the right upper quarter of the figure; *b* the button which first reaches *a* in turning the plate in the direction of the hands of a watch; *c* the plate of foil and paper—the armature—on the posterior face of the stationary plate opposite *a*, and in metallic connection with it, and *d* the comb and discharger in front of *c*. Let a', b', c' and d' be the corresponding parts on the left, and $e\,e'$ be the cross bar with its combs.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JAS. W. QUEEN & CO. PHILA.

THE ACTION OF THE TOEPLER-HOLTZ MACHINE.

When *a* and *b* come in contact, the friction excites electricity, and one of them must become positive and the other negative. What determines which shall be positive is unknown. It is sometimes one and sometimes the other. Suppose *a* is positive. As soon as *b* passes away, the positive of *a* is set free, and spreads to *c*, which thus becomes positive. Now *c* by induction draws negative electricity on to the revolving plate and repels positive to the discharger. Thus the revolving plate, as each point passes *d*, on a ring as wide as the comb is long, becomes charged with negative electricity. But at the same instant when *a* touches *b*, a' strikes b', and if *a* is positive, by a law of nature, a' must be negative. From it c' becomes negative, and draws from

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[1] London *Electrical Review.*

d^1 positive on to the revolving plate and repels negative to the discharger, and a ring of the revolving plate is charged with positive electricity.

But if the ring passing d, and charged with negative electricity comes in that state to a^1, which is also negative, all action must cease. To prevent this the cross bar e e^1 with its combs is placed nearly at right angles to the line a a^1, and neutralizes the rings of the plate, and thus every button meets a and a^1 in a neutral state, ready to go through the same process again. The whole office of e e^1 is to neutralize the parts of the plate as they pass it.

The part of the plate from d to e^1 is always negative, and that from d^1 to e is positive, while the parts e d and e^1 d^1 are neutral. The amount of electricity excited by a single contact of a and b, and of a^1 and b^1 is small, and hence the plate must be rotated a dozen, or more, times before the armatures become fully charged, and the tension sufficient to produce a spark between the discharging rods.

THE RAE "HORN" AMMETER.

The demand which has arisen for instruments adapted to indicate heavy currents has given rise to a variety of forms, not a few of which embody the principle of a movable core acted upon by a solenoid. In order to obtain an instrument which should be direct reading and at the same time have a scale with nearly equally spaced divisions over a large range of current, Mr. Frank B. Rae has designed an ammeter, which, on account of its peculiar construction has been termed the "Horn" ammeter. The accompanying engraving, Fig. 1 shows the new instrument in perspective and the details of its construction are shown in Figs. 2 and 3.

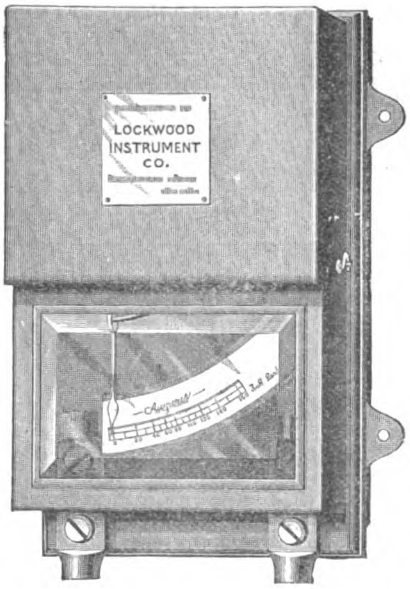
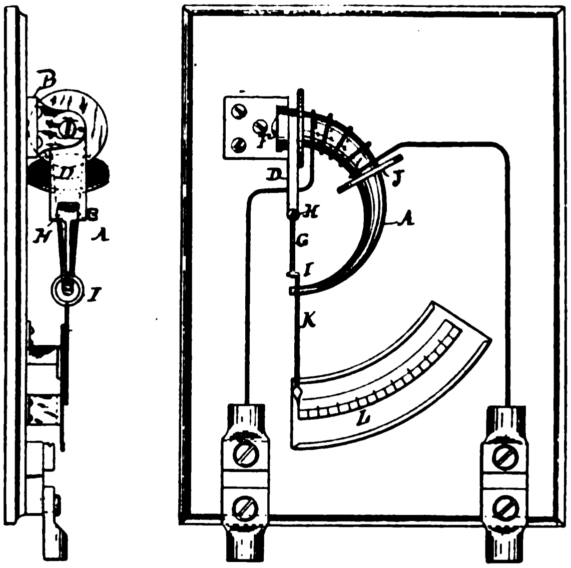


FIG. 2.—THE RAE "HORN" AMMETER.

The horn, A, forming the semicircular core piece is supported on a casting, B, and is made of wrought iron with a gradually tapering cross-section. Between the base of the core-piece and the bracket B is placed a plate D, of soft iron, and having a width equal to the large end of the core-piece and a length somewhat greater than the radius of the piece. This plate is interposed between the large end of the core-piece and the bracket, and the whole is secured together by an iron screw F.

The free end of this plate terminates at the centre of a circle, the circumference of which includes the curved piece, and in the end of this plate is mounted, by a hinged joint, a soft-iron armature G. The bearing portion of the latter is enlarged and rounded, as shown, so that it will present practically the same surface to the plate in whatever position the armature may assume under the action of the current. To the free end of this armature-piece is attached a ring I, of soft iron, the ring having an inner diameter equal to the diameter of the curved piece at the point J adjacent to the coils. Attached to the ring I is a pointer K, of light non-magnetic material and this pointer normally rests over the zero-point of the scale L in the form of a segment.

The action of the apparatus will now be clearly understood. Upon the current passing through the coil surrounding the core-piece, the armature and ring will be attracted, and, swinging on its pivot, the pointer will move over the scale and indicate the strength of the current flowing. It will be understood, of course, that the shape of the core-piece A and its variation in cross-section from its point towards its base is such that the attractive effect upon the armature and ring will not be in direct proportion to the strength of the current passing through the coils, but will increase directly as the pull exerted by gravity increases with the angle of swing, so that the movement over the scale is very nearly proportional to the current strength over the whole range. The ammeter, we may add, is made by the Lockwood Instrument Co., of Detroit, Mich.



FIGS. 2 AND 3.—THE RAE "HORN" AMMETER.

SECONDARY, PRIMARY AND STORAGE BATTERIES.

BY E. R. KNOWLES, C. E.

In reply to the very courteous criticism by Mr. Frederick Reckenzaun, of my article on "Secondary, Primary and Storage Batteries," which appeared in THE ELECTRICAL ENGINEER, of April 9th, I would like to say, that there was a twofold object why the terms "primary" and "storage" were assigned "to a class of batteries, namely, primary batteries capable of being regenerated by the action of an electric current"; first, not because "they have thus far acquired comparatively little practical importance," but because they are likely, in the near future, to attain very great importance, and it would be well to have their status clearly defined, namely, that they are storage batteries and not secondary batteries; and second, that the terms "secondary" and "storage" might not be confounded, as they most generally are.

A secondary battery is almost invariably a storage battery, but a storage battery is not always a secondary battery, but may be a primary battery. It is this fact, that "secondary," "storage" and "accumulator" have "been accepted as perfect equivalents" to the utter exclusion of any claims that the primary battery may have, that has caused a great deal of the confusion and litigation of late years. In the suit between the Accumulator company and

the Julien company, it was strenuously contended by the Accumulator company, that no primary battery was possible for use as a "secondary" or "storage battery" or "accumulator," and testimony to this effect by several noted experts was introduced; and yet the facts are quite the reverse, as, to the writer's knowledge, there are several primary batteries capable of doing good work as "storage batteries" or "accumulators," but not as "secondary batteries"; and it is wrong and confusing, to say the least of it, to make the terms "secondary" and "storage" synonymous. Because a bad precedent has been established in this respect, it does not follow that it is proper to persist in it, when once it is seen to be erroneous, and it is not clear that any confusion would result from the assignment of these terms to their proper places, but rather a clearing up of a confusion which now exists. No attempt is made to "steal" anything, but rather to restore to its proper place that which is already stolen.

A clear understanding of the exact status of these three great classes of batteries has another and very important bearing, namely, whether patents taken out for improvements in "secondary batteries" have any bearing at all upon "primary batteries" which may be made in the same, or similar, manner. An attempt was made to re-open the case between the Accumulator company and the Julien company, after a decision had been rendered, on the ground of newly discovered evidence, but the patent which was introduced was decided to be for a "primary" and not a "secondary" battery, although it was for practically the same thing, made in the same way. This is a very important point for the consideration of all who are engaged in inventing and perfecting in this branch of electricity, and who are desirous of accomplishing something which is not covered and crushed out of sight by a monopoly, as it would seem that it is to be.

"Primary" and "secondary" batteries, being two separate and distinct branches of this subject, by legal decree, it would seem that claims for "secondary" batteries would not hold good for "primary" batteries, and that here was a fertile field for inventive genius to work in.

TESLA'S THERMO-MAGNETIC GENERATOR.

The phenomenon that iron loses its magnetic properties suddenly at about a red heat and as suddenly regains them on cooling below that point has long been known, but it is only comparatively recently that advantage has been taken of it for its practical utilization. It is evident that by placing a coil of wire under the influence of a magnet alternately rapidly heated and cooled above the critical magnetic point, induction currents will be set up in the coil, due to the variation of the magnetism of the core.

This principle has already been applied in a number of ways in the construction of what are known as thermo-magnetic generators, or motors, and we are now enabled to describe another form designed by Mr. Nikola Tesla, who, it is interesting to note, obtained the first patent for a thermo-magnetic motor in the United States. The machine here described embodies several novel features of construction, which constitute a marked departure from the forms hertofore shown, and which consist first, in the employment of a closed magnetic circuit and an enclosed source of heat. The advantages gained by this arrangement will be apparent when it is considered that by the employment of a closed magnetic circuit a more effective magnetic change may be obtained and that by enclosing the source of heat and cooling the heated portion of the magnetic circuit the conversion may be rendered far more efficient. Other novel features are the employment of an armature of enormous cooling surface and steam as a cooling medium.

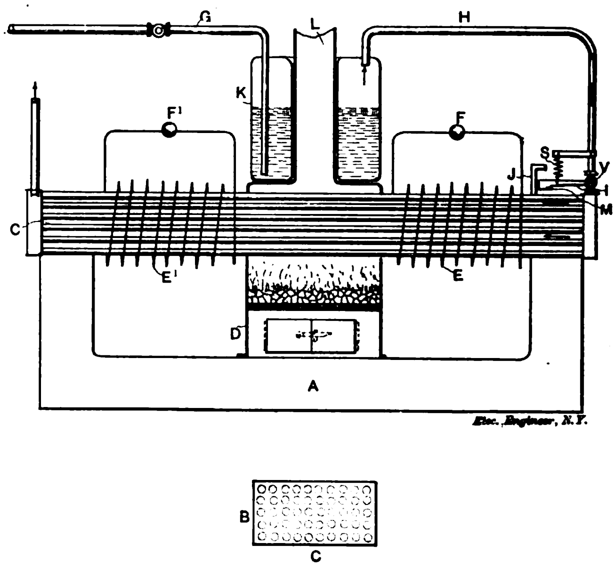
The accompanying engraving Fig. 1 shows a longitudinal section of the generator, and Fig. 2 a cross section of the magnetic armature core employed.

The generator is provided with a magnetized core or permanent magnet A, the poles of which are bridged by an armature core composed of a shell B, enclosing a number of hollow iron tubes G. Around this core are wound the conductors E E, forming the coils in which the currents are developed.

D is a furnace or closed fire box through which the central portion of the core B extends, and above the fire is a boiler K containing water. The latter is supplied by means of the pipe G, and the steam exhaust pipe H communicates with all the tubes C in the armature so that steam escaping from the boiler will pass through these tubes.

In the steam exhaust pipes is a valve V to which is connected the lever I, by the movement of which the valve is opened or closed. The lever carries an armature M, and is held up in position to close the valve V by means of a spring S. Stops are provided for limiting the movement of the lever, and the armature M is in proximity to the core B, so that it may be attracted towards the same, as will be described presently.

In its normal condition the armature B is magnetic along its entire length, and closes the magnetic circuit of the magnet A. Very little external or free magnetism is therefore exhibited, and the attraction upon the armature M is insufficient to draw it down against the force of the spring S. The steam exhaust, in consequence, remains closed. When, by the fire in the furnace, the temperature of the central part of core B has been raised to about from 900° to 1,000° C., the magnetic circuit of magnet A is broken, and, in consequence, the external magnetism of core B greatly increased. This attracts the armature M and allows steam to pass through the tubes C, of the core. This lowers the temperature of the surface of the tubes at once and restores to a corresponding degree their magnetic condition, whereupon the armature M is retracted and the steam cut off.



Elec. Engineer, N.Y.

THE TESLA THERMO-MAGNETIC GENERATOR.

This operation is continued, effecting a successive heating and cooling of the core, with the result of making and breaking the magnetic circuit. This entails a corresponding movement of the magnetic lines with reference to the coils E E, in consequence of which currents are developed in them.

It will be noted that by the construction adopted the source of heat is enclosed and the portions of the iron which are heated are not exposed to the air. The armature which closes the magnetic circuit is made of very thin tubes or laminae and by this means an enormous cooling surface can be obtained.

Steam is used for cooling in preference to air, partly because it is easier obtainable under pressure than air, and again, because it is more effective in consequence of its

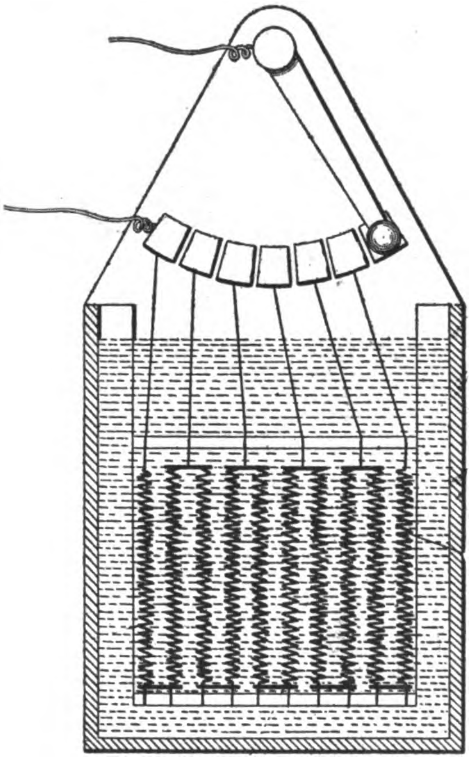
partial dissociation for which a large amount of heat is required.

Although the thermo-magnetic conversion itself may not be highly efficient, yet, since the steam used for cooling may be used for other purposes the system may be rendered economical under certain conditions.

BAIN'S IMPROVED RHEOSTAT.

The employment of rheostats is so frequent in electrical work, and their functions so important, that any improvement in this direction is worthy of notice. We therefore bring to the attention of our readers a neat adaptation for this purpose, by Mr. Forée Bain, of Chicago, by means of which, considerable economy in the cost of rheostats can be effected, especially those designed for heavy currents, and possessing also a number of other advantages.

The arrangement, which is a very simple one, is illustrated in the accompanying engraving, and consists in merely immersing the conductor in a liquid which is itself a non-conductor, but which has a great cooling effect upon the wire.



BAIN'S NEW RHEOSTAT.

As an example of this, Mr. Bain states that a No. 20 iron wire submerged in a vat containing water is capable of carrying for an unlimited time a current of 115 amperes, and while, of course, the water decreases the resistance of the coils, it is found that this decrease is very small, being practically not over two per cent.. while the carrying capacity of the resistance medium is increased many times, as shown.

Besides the saving in wire and smaller space occupied by the rheostat, the danger from fire by overheating is prevented, as, evidently, the wire cannot be heated beyond the boiling point of the liquid in which it is immersed.

....WHEN a current of electricity has to pass through two pieces of metal in contact, the first condition is that the surfaces should be clean, and that is precisely the condition which cannot always be fulfilled in a tramway exposed to the weather and overrun by other traffic.—*Gisbert Kapp.*

THE WESTINGHOUSE ALTERNATING CURRENT METER.

AMONG the large number of apparatuses designed to measure electric energy, various forms of watt-meters have been brought out depending in the most cases upon the inter-action of two parts or coils, one of which carries the current and the other is energized at the constant potential of the circuit. Meters of this class have heretofore been adapted for continuous currents only, but recently Mr. George Westinghouse, Jr., has devoted some attention to the problem of applying it to alternating current meters as well.

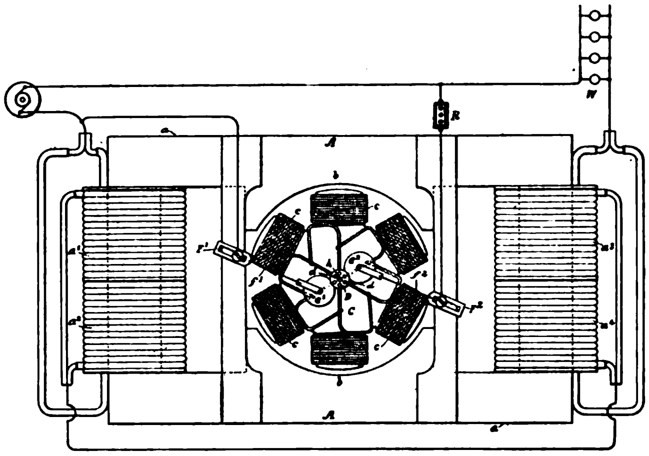


FIG. 1.—THE WESTINGHOUSE ALTERNATING CURRENT METER.

The results obtained by him are embodied in the meter illustrated in two views in the accompanying engravings. In these the field magnets of the motor portion of the meter consist of a soft iron laminated core a having consequent poles at b. The coils a^1 a^2 a^3 a^4 are wound about the core at its respective ends in four divisions, which may be connected in the work-circuit conductor either in series or in multiple, or in multiple series, to suit the requirements of the different circuits. The armature C consists of a polar magnet having a core composed of laminæ of soft iron and wound with the coil c, the terminals of which are connected with the commutator D. Electrical connection is made with the plates of the commutator by means of wheel contacts e^1 e^2 carried upon the spring-arms f^1 f^2, and electrical connection is made with the supports F^1 F^2 of these arms for connecting the armature in shunt upon the work-circuit W.

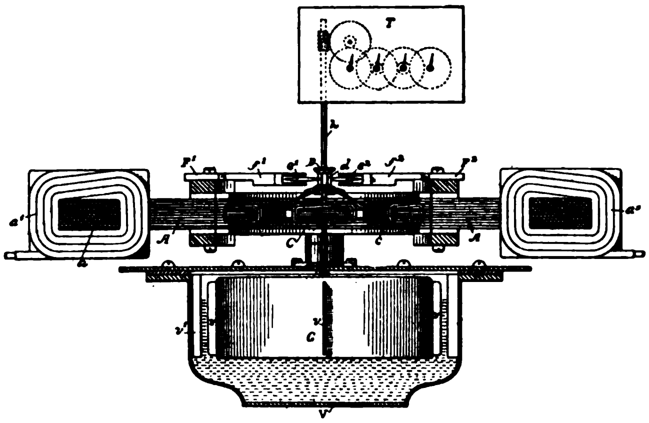


FIG. 2.—THE WESTINGHOUSE ALTERNATING CURRENT METER.

The armature is mounted upon the shaft h which is stepped in a float G; the latter is carried in a basin V containing a fluid, the float turning with the shaft. The revolutions of the armature are registered by means of a counting-train T.

For the purpose of retarding the motion of the armature and rendering its rate of revolution proportional to the work being done at different velocities, vanes are carried by the float G, and these revolve in the fluid which is contained in the basin.

With this construction, according to Mr. Westinghouse, upon a constant potential circuit the armature will receive a constant polarization, while the field of force will vary as the current. Therefore the retarding influence should vary directly as the speed. The result is sufficiently approximated for practical purposes by the use of the vanes and float.

TESTS ON THE FUSING POINT OF FUSE WIRES.

In the following we give the results of certain tests made on fuse wires in the Laboratory of the Massachusetts Electrical Engineering Co. They were made at the request of the engineering department of the company, in order to determine more positive data than was known regarding the actual fusing points under varying conditions of use of such wires.

The method of conducting these tests was as follows :— Fuse wires of various grades and makes were bought from the most reliable dealers. By a conveniently arranged switch, ammeter and adjustable resistance, any current up to 200 amperes could be passed through the piece of wire under test for a given length of time. The current could either be gradually increased through the fuse wire or be adjusted to any strength, and then suddenly passed through it.

The following table is made up from averages of a number of the tests made on smaller sizes of wire :—

Nominal amp. or safe carrying capacity.	Fusing point in less than 10 seconds. 1 inch long.	Fusing point in 30 seconds. 1 inch long.	Fusing point in 10 seconds 2 inches long.	Fusing point in 10 sec. in closed box. 2 inches long.
2.	7.0	6.0	6.6	6.6
2.5	7.8	6.2	7.3	7.2
3.	12.0	9.2	10.0	9.8
3.5	12.5	10.0	10.6	10.2
4.	13.0	11.0	11.0	10.7
6.	14.7	13.8	13.5	12.1
7.	15.3	14.5	13.2	12.9
8.	18.0	16.5	14.0	13.5
10.	20.0	18.7	18.0	17.6
15.	36.0	34.0	28.0	27.0
20.	53.0	47.5	45.0	43.5

A similar series of tests were made on several makes of wires, and the following conclusions reached :—

A longer piece of wire will fuse with less current than a shorter. This is due to the less rapid conduction of heat from the centre of the fuse wire into the binding posts and main wires.

The fusing point in a closed box is lower than that in the open air, the difference varying with the conditions in each case and due to the more or less rapid radiation of heat from the wire.

The fusing point varies with the temperature of the air surrounding the wire.

The fusing point varies with the length of time the current flows; that is, it will fuse at a lower point if the current flows for a longer time.

The requirements for a good fuse wire are :—

(1) The nearest approach possible of the fusing point to the safe carrying capacity.

(2) A constancy under varying conditions of position and temperature.

(3) Rapidity of fusing at the proper current.

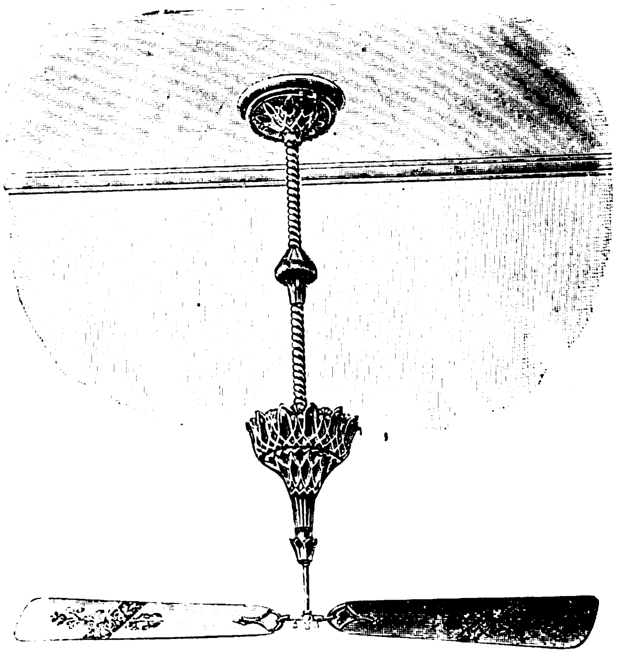
(4) It should not throw the particles of molten metal or "splutter," thus endangering the surroundings from fire.

The best wires tested had a fusing point in enclosed space for the smallest sizes, of about 200 per cent. above their safe carrying capacity, of the medium sizes of about 100 per cent. and the largest sizes of about 50 per cent., and less, above their safe carrying capacity. These tests and experiments are being carried still further in this laboratory with a view of devising, if possible, some better system of fuses.

THE DIEHL SUSPENDED MOTOR FAN.

As the heated term approaches, the subject of ventilation in buildings takes a prominent position, and as in everything else at the present time requiring the application of small units of power applied at numerous points, the electric motor is called upon to furnish the required energy. The small motor is eminently adapted for this service, and finds in this field an application which has already involved the employment of thousands of such machines. Mr. Philip Diehl, of Elizabeth, N. J., has given considerable attention to this subject and has designed a suspended motor fan which embodies a number of features that make it eminently adapted for the particular purpose for which it is designed.

The fan is illustrated in the accompanying engraving and will be seen to consist of a small continuous current motor, which is practically hidden in the metal basket shown, and to the armature shaft of which are attached two fan blades. The small motor is usually wound for 110 volt circuits and revolves at 200 revolutions, a low speed and one calculated to revolve the five-foot fan blades with most effective results. A rheostat, which can be placed in circuit, varies the speed as desired, however.

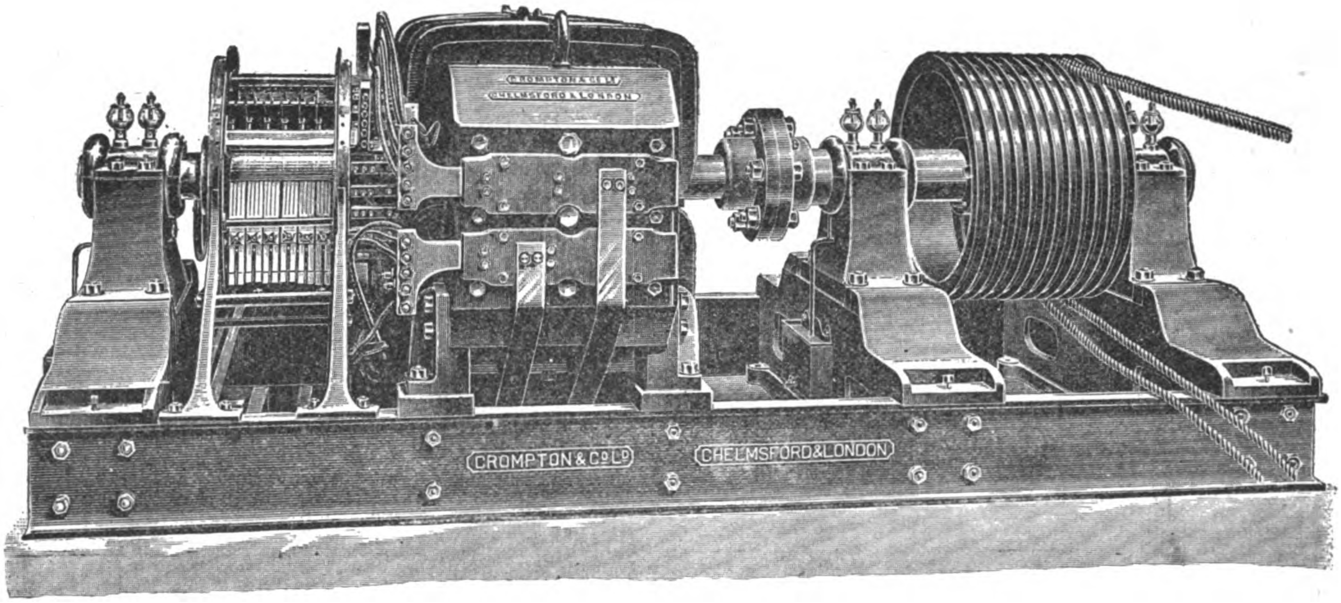


The Diehl Suspended Motor Fan.

The construction of the small motor embodies a Gramme ring which revolves outside of the field magnet. The latter is made of drop-forged wrought iron, and is made in one piece and wound continuously. The armature ring has a core of soft iron wire, and the winding of both field and armature is effected automatically, the winding of the armature being accomplished by a special machine of most ingenious construction. The armature runs on hardened steel ball bearings placed in a cup-shaped ring, which is filled with lubricant and which permits the motor to be run a long time without any attention whatever. On account of the slow speed employed, the commutator and brushes wear very little, a result that is also brought about by the use of Tobin bronze for the commutator sections.

The motor and fan are suspended by a rod, which can be varied in length so that the blades can be placed at any height from the ceiling. This, however, can be done independently of the motor and fan blades, which form one integral part, the suspension rod being entirely independent. The wires leading to the motor are concealed in the extension rod and the whole is suspended on a hook by the employment of which the fan and motor seek their true center of gravity and thus prevent all disturbing vibration. Besides this type of fan, Messrs. Diehl & Co., of Elizabeth, N. J., manufacture various other types and also their well-known sewing machine motors, as well as motors for all stationary purposes. All these machines are constructed with interchangeable parts, and are built at the well-known Singer Sewing Machine Works, renowned for the accuracy and quality of their output.

CROMPTON FOUR-POLE DRUM DYNAMO.[1]



New Crompton Four-Pole Dynamo.

The above illustration shows a new four-pole drum machine made by Messrs. Crompton & Co.,Ld., Chelmsford. We feel confident, says *Industries*, that the single magnet two-pole drum dynamo now in almost universal use will give way to the four-pole type for sizes above 200 watts per revolution. The four-pole machine seems to have everything in its favor. The end couplings, which are the most troublesome part of two-pole machines, are beautifully simple when four poles are used, as the connections are only a quarter round the armature, and do not tend to foul the spindle or to block up ventilation spaces. Besides this, they are infinitely more accessible, a point of great importance with reference to repairs. If a four-pole machine has the same number of active conductors, the loss by hysteresis in the armature is approximately the same as in a two-pole machine, for, though the iron is reversed twice as often, there is only about half the volume ; or if, on the other hand, the radial depth is kept as before, the induction is very much lower. For large currents the four-pole drum is especially suitable, as the current in each conductor is one-fourth of the whole current, and the commutator sections are more numerous than in the corresponding two-pole machine.

The machine we illustrate has an output of 50 volts and 2,500 amperes at 400 revolutions per minute. The armature has 48 external conductors of 185 strands of No. 16 B.W.G. twisted and compressed into a rectangular cross section. The armature diameter is 22 in. It is built of discs keyed to a soft steel spindle. The spindle is made in two parts, coupled by a cast-iron coupling, and fitted with a pulley for rope driving. There are three bearings, and these have only the bottom brasses lined with white metal. The magnets are wound with 13 layers of copper strip 0.19 in. by 0.24 in., resistance cold 0.9 ohm, all in series. The magnets are 26 in. by 11½ in. There are four sets of six brushes each. The opposite brushes are coupled together in parallel. Each brush is 2 in. wide. The machine is mounted on a bed-plate built up of two channel girders of wrought-iron, to which the pedestals of the magnets and the bearings are bolted.

One of the chief advances in this machine is the engineering design of the armature conductors. These have faced joints, and are screwed together with steel bolts and nuts. So perfect is this system, and so simple are the end connections, that the whole armature can be stripped in four hours, and put together in a somewhat longer time, including new bands. A repair, if ever necessary, could be executed in a very short time, unless, of course, the bands had to be taken off. This dynamo is for smelting work, a branch of electric business in which, as is well known, Messrs. Crompton have been particularly successful.

Two large dynamos, each capable of delivering several thousand amperes of current, are already in operation at the works of the Aluminium Smelting Syndicate at Milton, near Stoke-on-Trent, England. They are there employed in the reduction of aluminates, such as corundum, according to Cowles process as practiced at the Cowles works at Lockport, N. Y., where, as will be remembered, several large Brush machines which furnish the current for the reduction, are driven by water power.

THE CARTWRIGHT ELECTRICAL PROTECTOR.

With the increasing number of wires carrying heavy currents run in close proximity to others connected to instruments requiring but very small currents for their operation such as telephones, fire and police signal apparatus, etc., it becomes desirable to employ some device to prevent the destruction of the latter instruments by burnouts, which may be caused by the crossing of the wires carrying the heavy and light currents, respectively. As the recent large fire in Boston is by some ascribed to an accident of this nature,notwithstanding the report of a great many respects to the contrary, interest has been aroused in that city in devices for the protection of circuits designed to carry light currents and among them the Cartwright

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[1] *Industries.*

"electrical protector," has attracted considerable attention. This instrument is shown in perspective in Fig. 1, and Fig. 2 is a diagram of the electrical connections.

As will be seen, the iron core, A, is supported on two angle irons, B, attached to the base plate, and which are in connection with the ground terminal, G. Two helices, separated from each other in the middle by a rubber washer, and made of coarse wire, are wound on the core, their inside ends being connected through the terminals, F F, to the line, and the outside ends through the armature lever, H, through terminals on the other side of the instrument to the apparatus to be protected.

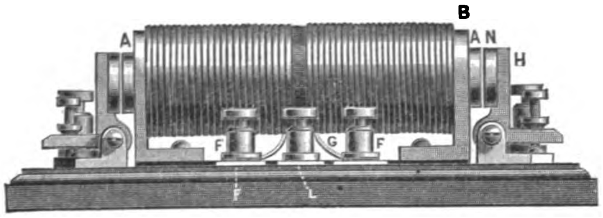


Fig. 1.—Cartwright Protector.

The armature lever is so adjusted by weight or by springs that the normal current has not sufficient strength to attract it, but as soon as an abnormal current comes in over the line the armatures are attracted to the core, and the current is shunted to the ground, the telephone or other instrument being cut out. Another form of this instrument is illustrated in outline in Fig. 3. In this form, which is employed at terminal stations, a single helix is used. It is composed of an ordinary electro-magnet, whose armature-lever, H, is provided with a metallic spring, c, which, when the armature is attracted, makes contact with a contact-point, *d*, connected with the line if at an intermediate station, and at the ground if at a terminal station. One terminal of the instrument to be protected, such as a telephone, is connected to this contact-point, and the other terminal of the telephone is connected through the armature to one end of the coil of the electro-magnet. The other end of the coil of the electro-magnet is connected to the line, and the core of the electro-magnet is connected to the earth.

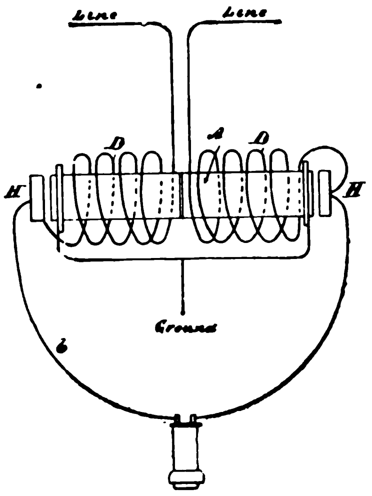


Fig. 2.—The Cartwright Protector.

When the current is normal the instrument to be protected is in the circuit; but when a current of abnormal strength comes on the line the armature lever is attracted, and the spring, *c*, makes contact with the contact-point, *d*, thus cutting out the telephone and connecting the line to ground through the armature and the core of the electro-magnet.

An important feature of the apparatus is that it not only protects the instruments and circuit, but enables the ringing in of an alarm from any point, on a fire-alarm circuit for instance, even when the outside wires are crossed by an abnormal current. This is effected by a combination of the protectors and fuses, so arranged as to temporarily cut out the deranged or crossed wire between any two boxes, and to substitute a ground to complete the circuit between these boxes.

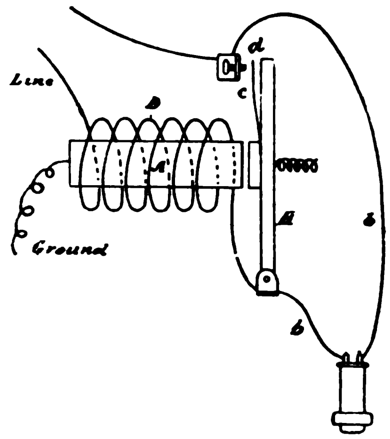


Fig. 3.—The Cartwright Protector.

ON THE SHAPE OF MOVABLE COILS USED IN ELECTRICAL MEASURING INSTRUMENTS.

In a note presented to the London Physical Society on the above subject Mr. J. Mather seeks to determine the best shape of the horizontal section of swinging coils such as are used in D'Arsonval galvanometers, electro-dynamometers, wattmeters, etc. Assuming constant period and constant moment of inertia about the axis of rotation, it is shown that for zero instruments the best shape of the section is two circles tangential to the direction of the deflecting field at the point about which the coil turns. A table accompanies the paper, in which various forms of section are given, together with their relative deflecting moments per unit moment of inertia; the coils being taken of equal lengths and the current density being constant. From this table it appears that ordinary D'Arsonval coils only give about 45 per cent. of the maximum deflecting moment, and ordinary Siemens' dynamometers from 40 to 53 per cent. The various assumptions made in the paper are shown to be justifiable in commercial instruments, and the modifications necessary in special cases are pointed out.

Mr. C. V. Boys said he had, when working at his radio-micrometer, arrived at a shape similar to that recommended in the paper. He also noticed a peculiar relation time for all shapes where the length parallel to the axis of rotation is great compared with the breadth. Suppose a coil of any dimensions, then another coil of half the breadth and double the length, and cross-section, will be dynamically, electrically and magnetically the same as the original, for the moment of inertia, the electric resistance, and the enclosed magnetic field are equal. The above relation is also true when the breadth is not small, if the cross-pieces be thickened near the axis so as to make their moment of inertia proportional to their length. He inquired whether the author had considered the subject of grading movable coils; he, himself, was of opinion that, unlike fixed galvanometer coils, the wire near the axis should be thicker than that further away.

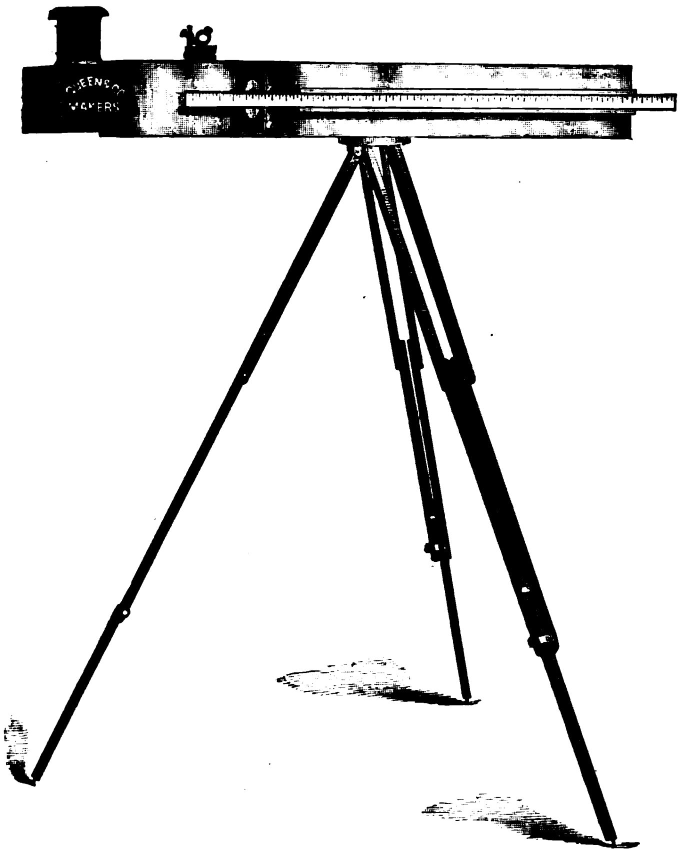
Prof. Ayrton remarked that in 1881 Prof. Perry and himself exhibited a wattmeter at the Society of Arts, whose movable coil somewhat resembled one of those in the paper which gave a deflecting moment of 95 per cent. of the maximum. In designing the instrument they had felt that the ordinary method of using a comparatively large swinging coil was not the best, and this led them to the shape adopted.

....A simple calculation shows that with bearings perfectly in line, and good lubrication, a wrought iron shaft of uniform thickness and two miles in length, cannot be turned from one end because the resistance of friction is greater than the torsional moment which can safely be applied.—*Gisbert Kapp.*

NEW PORTABLE PHOTOMETER.

To meet the demand created by the rapid adoption of the electric light for town and city lighting, and the consequent necessity of making frequent tests for the purpose of conforming to certain standard conditions, Messrs. James W. Queen & Co., of Philadelphia, have recently brought out a new form of Bunsen's photometer. The instrument is made very compact, being designed especially for street work by government inspectors and experts having occasion to make candle power tests of arc and incandescent lamps.

The apparatus, which is illustrated in the accompanying engraving, is mounted on a tripod, and is 5¼ inches square in cross section and 38 inches long, and made of polished cherry. The lantern, as shown, slips into one end of the box, where it is firmly held; a small adjustable holder carries the standard light, which may be either one or two standard candles. This adjustment regulates the height at which the flame stands, and also its distance from the screen; by making the latter distance exactly one foot, computation is greatly facilitated. Distances are measured by a graduated bar shown, which slides in grooves along the side of the box.



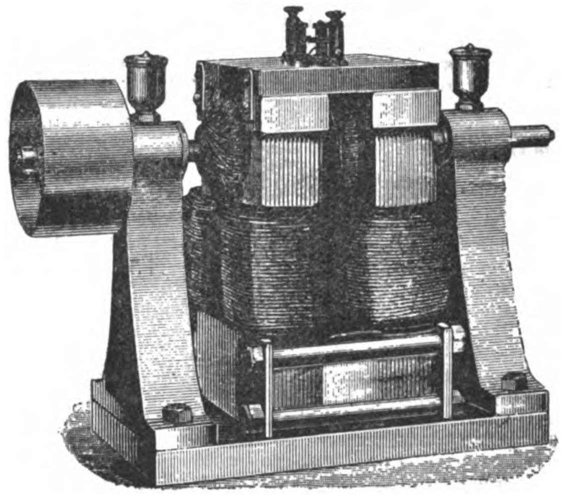
New Portable Photometer.

To allow for the difference in vision between the right and the left eye, the instrument is made reversible, that is, it may be turned completely over so that the right eye observes the side of the disc before observed by the left, and vice versa. When not in use the lantern chimney slips out and can be placed inside the lantern itself, after which the entire lantern box may be pushed inside the photometer, and small slides made to cover the two ends and the sight hole of the instrument, making a solid box of it. A brass handle on one side allows the instrument to be carried as easily as a small hand bag. A small incandescent lamp can, of course, be used as a standard instead of candles. The range of the instrument is from about four candle power up, and it has already been very successfully used in several tests involving expert opinion.

KENNEDY'S ALTERNATING MOTOR.[1]

The accompanying engraving represents Mr. Rankin Kennedy's new alternating electric motor. It consists of two ordinary dynamos, with ring or drum armatures (drum armatures being shown in the engraving), and laminated field magnets; both armatures are on the same shaft, their coils being connected together. One of the machines acts as the motor, the other taking the place of the commutor; there are no brushes and no commutator, and, therefore, one gets an entire absence of sparking.

The motor requires two currents, one at a quarter of a complete alternation in advance of the other; but it does not require any synchronising, and it can start with load on from rest. The two currents at different phases are obtained from a transformer or two line wires with a third for a common return, or from a coil wound on the field of one of the combined machines. Larger machines are made multipolar.



Kennedy's Alternating Current Motor.

SOLAR ACTION ON ELECTRIC CHARGES.

MM. T. Elster and H. Geitel have found that pieces of polished metal do not preserve a negative charge of electricity after being exposed to the rays of the sun, or even to the light of day. The positive charge, on the other hand, can be quite well preserved. In a dim light both charges can be kept, and this effect is more sensible for magnesium and aluminium than for zinc. Plates of polished metal exposed to the sun's rays are charged positively. A film of water, or even of mist, on the surface is quite enough to prevent these actions almost entirely.

THE RESISTANCE OF CONDUCTORS TO TRANSIENT CURRENTS.

At a recent meeting of the Royal Society of Edinburgh, Sir William Thomson read a paper recounting an accidental illustration of the effective ohmic resistance to a transient electric current through a steel bar. He said that at the recent meeting of the British Association at Newcastle, Lord Armstrong had told him of an interesting incident. A bar of steel about a foot long, which he (Lord Armstrong) was holding in his hands, was allowed accidentally to come in contact with the two terminals of a dynamo. He instantly felt a painful sensation of burning, and he let the bar drop. He found his fingers where they had been in contact with the bar severely blistered. The bar was found immediately afterwards to be quite cold. This proved the outer surface of the steel to have been intensely heated, and that not enough of heat was generated to sensibly warm the whole bar. Lord Armstrong had sent him the bar and some further details. There were two hollows burned out of the metal at the points where the bar touched the terminals of the dynamo. Lord Armstrong had held the bar midway between the two marks. It was perfectly cold three or four seconds after he dropped it. The dynamo gave an alternate current of 85 amperes, at a difference of potential of 103 volts. Sir William Thomson then showed how the theory involved could be worked out by Maxwell's fundamental equations of electro-magnetism. He discussed the theory at some length, and showed that there was a thermal analogy.

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[1] London *Electrical Review*.

THE ELECTRICAL EXHIBITS AT THE PARIS EXPOSITION.[1]

BY CARL HERING.

BARE AND INSULATED WIRES AND CABLES.

GENERAL.

THE bare wire exhibits were confined almost entirely to the French section, and were in general very creditable, showing fineness of work and results of considerable, and apparently successful, research to obtain a mechanically strong wire of high conductivity for line wire. High insulation, water-proof wires were equally well exhibited by France and the United States; in the former the insulation used was almost entirely of soft rubber and gutta-percha while in the latter it was principally paraffine and rubber compounds. The cable exhibits were confined to a few large, well-known companies from France and England. The cable industry in France has developed almost entirely during the last 10 or 15 years, before which time their cables were made almost entirely in England. There were a few insulated wire exhibits from Russia, Japan and elsewhere, but without particular interest.

HISTORICAL.

Among the historical exhibits was a sample of an underground wire laid between Baltimore and Washington in 1844. It consisted simply of a copper wire, about No. 18 B. & S. gauge, covered with an insulating compound and enclosed in a lead tube. It was exhibited by the Western Electric Co.[2]

BARE WIRES.

The exhibit of bare wires of the firm of J. O. **MOUCHEL** (French section, Gold medal), was undoubtedly the finest of its kind and was particularly interesting on account of the fineness and regularity of their goods, as also on account of the very elaborate researches made by them with different alloys, to obtain great tensile strength combined with good conductivity for line wires, and to obtain great resistance with small temperature co-efficient, for resistance coils.

These are probably the oldest wire manufacturers in France, dating as far back as 1709. They employ at present 200 hands (of whom 120 have been there more than 10 years!) and 450 h. p. Their specialty is fine, delicate work, purity of alloys, length of pieces and regularity of diameter.

The following table gives the results of their elaborate experiments made in 1884 to study the effects of small quantities of foreign metals alloyed with copper:

Wires 0.50 mm. diameter, annealed. Alloys of pure copper with 1 part of the following metals (pure) in 1,000.	Resistance per kilometre in legal ohms at 0° C.	Conductivity.	Elongation.	Ultimate tensile strength in kilogrammes per sq. millimetre.
Lead	78.21	104.04	36.20	19.09
Molybdenum	78.78	103.28	33.50	21.90
Cobalt	79.17	102.77	38.15	20.62
Silver	79.30	102.60	4.25	29.02
Sulphur	79.31	102.59	37.55	21.51
Gold	79.35	102.54	33.45	20.62
Selenium	79.43	102.44	30.42	27.23
Thallium	79.44	102.42	36.10	21.26
Zinc	79.59	102.22	35.32	27.06
Antimony	81.30	100.08	300.0	22.91
Tellurium	81.50	99.84	1.82	41.35
Platinum	81.98	99.25	38.80	20.37
Nickel	82.72	98.37	39.00	20.88
Tungsten	84.08	96.77	36.35	21.51
Tin	84.49	96.31	3.65	32.42
Chromium	85.64	95.01	33.55	22.92
Magnesium	86.29	94.29	3.75	36.54
Aluminium	89.86	90.55	35.20	22.15
Magnesium	90.09	90.31	33.75	27.57
Iron	97.65	83.32	32.65	22.05
Arsenic	105.17	77.36	39.10	21.77
Silicon	120.44	67.55	20.65	18.33
Phosphorus	149.84	54.30	31.25	23.42
Bismuth Cadmium Potassium Sodium	Unman	ageable	....	....

The different effects of different proportions are seen in the two following striking examples: $\frac{1}{10}$ of one per cent. of phosphorus reduces the conductivity of copper to 54.30 %, while 5¼ % reduces it only to 10.079 %. With arsenic $\frac{1}{10}$ of one per cent. reduces copper to 77.96 %, while 5 % reduces it to 5.72 %.

They exhibited also a pure copper wire, the conductivity of which is 104.69 % deduced from measurements which were controlled at the Vienna Exposition and certified to by Messrs. Blavier, Stefan and Discher. The high conductivity of copper, which is doubtless correct, simply shows that the generally accepted value for pure copper is too low. Next to this exhibit of remarkably high conductivity there was shown, by way of contrast, a similar wire of .50 mm. of remarkably high resistance, made of an alloy of copper and arsenic, having a resistance of 2,335.50 ohms per kilometre, which is equivalent to a conductivity of 3.48 % or about double the resistance of German silver.

Their regular copper telegraph wire, annealed, has a conductivity of 102.5 %, an elongation of 35 to 38 %, and a breaking strain of 20 to 25 kilogrammes per sq. mm. (28,000 to 35,000 lbs. per sq. inch), depending on the degree of annealing. The co-efficient of temperature is .40 % per degree centigrade.

Their two principal bronzes have 98.5 % with 45 kilogr. (64,000 lbs. per sq. in.), and 34.6 % with 75 to 90 kilogr. (107,000 to 128,000 lbs. per sq. in.), as conductivity and breaking strain respectively. These can be wound around a wire of their own diameter without showing any breaks. The former will stand 20 bendings in a vise, and the latter 30 to 35.

Their experiments with magnesium have given very interesting results, showing great strength combined with good conductivity. The following figures show some of the results:

Tests With Magnesium-Copper Wires.

Conductivity.	Breaking strain.
95.16 per cent.	51.80 kilogr. per sq. mm.
81.60 "	61.09 " "
63.89 "	75.17 " "
58.01 "	81.37 " "
51.43 "	95.49 " "
50.61 "	76.47 " "

They find it impracticable to go below 50 % conductivity, or above 70 kilogr. breaking strain. For exceptionally great spans of line wire they have arrived at 100 to 110 kilogr. with a conductivity of 21 %. These figures are nearly the same as those of the silicium bronze wire exhibited by Weiller, described below.

Their German silver resistance wire has a conductivity of 7.35 to 4.40 %. They find that while all known alloys increase in conductivity on being annealed, the German silver will decrease when the proportion of nickel is greater than 10 %.

Their new high resistance arsenic alloy containing 10 % of arsenic, has a conductivity of only $3\frac{1}{3}$ % and a temperature co-efficient of only .0258 % per degree centigrade (that of German silver being .0393 %). This alloy is very difficult to work, but in spite of this they exhibited it drawn to the remarkably small diameter of 17 thousandth of a millimetre, or .00067 inch, or about $\frac{1}{10}$ as fine as No. 34 American gauge! The resistance of this wire is 2,052 ohms per metre!

Another curiosity which they have made is a coil of telegraph wire in a single piece (without any joints) weighing 660 pounds. This was before electric welding came into use.

LAZARE, WEILLER & CIE., (French section, Gold medal) had a fine exhibit of bare wire, chiefly of their patent Silicium Bronze, which appears to be their specialty. They claim as advantages for this line wire, over the usual iron or steel wire, that for the same conductivity the weight per mile is several times as small; that, therefore, it is much easier to run; that it diminishes the dimensions and number of poles and insulators; and, that owing to its increased strength, there is less danger to rupture from wind and snow; also, that it is absolutely inoxydizable.

The following figures, taken from their tables, show the most important properties. For long telegraph lines a silicium bronze telegraph wire of 2 mm. diameter (.079 inch, or about No. 12, B. & S. gauge) weighing 28 kilogr. per kilometre (100 lbs. per mile) has the same resistance as, and can replace, the usual galvanized iron wire 5 mm. in diameter (.197 inch, or about No. 4, B. & S. gauge) weighing 155 kilogr. per kilometre (550 lbs. per mile) and having a resistance of 5.40 ohms per kilometre (8.7 ohms per mile.) For telephone lines, a silicium bronze wire of 1.1 mm. diameter (.043 inch, or about No. 17, B. & S.) weighing 8.45 kilogr. per kilometre (300 lbs. per mile) has the same resistance, and can replace a steel wire of 2 mm. diameter (.079 inch, or about No. 12, B. & S. gauge) weighing 25 kilogr. per kilometre (89 lbs. per mile) and having a resistance of 40 ohms per kilometre (64 lbs. per mile.)

The conductivity and the tensile strength may be varied at pleasure, for different purposes; as one quality increases, the other diminishes. The following figures, showing the properties, are taken from their tables:

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[1] Advance sheets of the report of the expert of the U. S. Commission to the Paris Exposition, Section "Electricity."

[2] See also description of exhibits of Henley and Menier, below.

Size of silicium bronze wire 1.5 mm. or .059 inch, or No. 15 B. & S. Gauge.	For long distance telegraph lines.	For long span telegraph lines.	For telephone lines.	For telephone lines, new type.	For telephone lines, for long spans.
Weight in kilogrammes per kilometre........	15.75	15.75	15.75	15.75	15.75
Weight in lbs. per mile.	56.	56.	56.	56.	56.
Tensile strength in kilogrammes per sq. mm.	45.	56.	75.	80.	112.5
Tensile strength in lbs. per sq. inch..........	64,000	79,600	106,600	113,800	160,000
Resistance in ohms per kilometre..........	9.45	11.42	28.8	21.77	43.53
Resistance in ohms per mile..............	15.2	18.4	46.4	35.0	70.0
Conductivity per cent. as compared with copper (having 20.57 ohms per kilometre per 1 mm. diam.)..........	97.	80.	32.	42.	20.

Charles Martin & Cie., (French section, Bronze medal) exhibited a line wire called "bi-metallic," consisting of a core of steel, and a thick, solid layer of copper around it and united to it. The proportions of copper and steel are about half and half. It is made not only for telegraph and telephone lines, but also for the transmission of power and light, as well as for electric bell circuits. Pure copper wire would be best for lines if it were not for the high price, and the fact that it is so soft that it is apt to tear when in long spans, or to elongate by its own weight, thereby diminishing its cross section and increasing its resistance. The object of this bi-metallic wire is to combine great tensile strength with good conductivity, small weight and cheapness. The advantages claimed over the phosphor and silicium bronze wires are, that the latter are brittle, and will not stand bending or twisting, and, that in course of time, they become granular or crystalline, and that they are expensive. The object of the bi-metallic wire is to combine the good conductivity of copper with the tensile strength of steel, and at the same time use the copper sheath to protect the steel from the action of the air and water. The process is not described, being apparently a secret. The two metals are firmly united, as though they were welded. The weight and diameter are evidently less than that of a steel wire of the same conductivity would be, and it is claimed to resist a greater tensile stress than copper wire. It is claimed to resist perfectly bending and torsion, and that it is quite flexible and elastic. The selling price for 1 mm. diameter and over is given as 150 francs per 100 kilogrammes, which is equal to about 13 cents per pound.

There is a disadvantage in its use, however, namely, that if the steel should be exposed anywhere, the action of moisture will be to destroy the steel at that place much more rapidly than if it were not covered with copper, because the steel and copper form a short-circuited electric couple the action of which is to decompose the iron and to clean the copper. In galvanized iron wire this electrical and chemical action is just the reverse, as it keeps the iron clean at the expense of the zinc.

Copper-covered iron wire was made in the United States more than a dozen years ago, and for the same object. It was made by electro-plating the iron wire with a thick coating of copper. But it was found that the iron wire appeared to absorb in its pores some of the liquid of the bath, which in time destroyed the iron completely by the action described above. All the lines run had to be replaced, and the extensive wire works had to be abandoned. It is presumed, therefore, that the process of Martin is not the same. In one specimen the steel was 1⅛ inch in diameter, and the copper ⅜ inch thick.

The following figures give the results of some tests of the Martin bi-metallic wire. They were made at the Laboratoire Centrale d' Electricité of the Société Internationale des Electriciens:

External diameter, 3 mm., or between Nos. 8 and 9, B. & S. gauge.

Ultimate tensile strength, 388 kilogr., or 55 kilogr. per sq. mm.; or 78,000 lbs. per sq. inch. (That of copper is about 26 kilogr. per sq. mm.; or 37,000 lbs. per sq. inch.)

Elongation, 28 per cent.

Number of times it could be bent through a right angle alternately in opposite directions when held in a vise, 20 to 24.

Resistance per kilometre at 14° C., 3.91 ohms, or 6.3 ohms per mile. (That of a copper wire of the same diameter is 2.35 ohms per kilometre, or 3.96 ohms per mile. That of an iron wire of the same diameter is 14.05 ohms per kilometre, or 22.6 ohms per mile.)

From these figures the following deductions may be made:

Its conductivity is 60 per cent. of that of copper, and 360 per cent. of that of iron wire of same diameter.

The size of a copper and iron wire of the same resistance would be 2.33 mm. and 5.7 mm., or about Nos. 11 and 3, B. & S. gauge, respectively.

The weight of the bi-metallic wire is given as 62.5 kilogr. per kilometre, or 222 lbs. per mile.

That of the iron wire would be about 200 kilogr. per kilometre, or 700 lbs. per mile.

For the same weight of wire on the poles, the number of lines of the same resistance could therefore be tripled, as compared with iron wire.

Or, for the same weight as the iron wire, the size of the bi-metallic wire would be 5.4 mm. (between Nos. 3 and 4) and its conductivity increased 3.2 times.

Another test made by the same parties gave the following results:

Diameter, 1.29 mm., or No. 16, B. & S. gauge.

Ultimate breaking tensile strain, 84.5 kilogr., or 65 kilogr. per sq. mm., or 92,000 lbs. per sq. inch.

Number of times it could be bent backward and forward over a bar 10 mm. (.4 inch) diameter, 50 to 60.

Resistance, 19.61 ohms per kilometre, or 31.6 ohms per mile.

Resistance as compared with copper wire of the same diameter, 66 per cent.

INSULATED WIRES.

Fortin-Hermann (French section, Gold medal) exhibited an insulated wire made of a bare copper wire on which are threaded small, short, wooden beads, quite close to one another, the whole being afterwards covered with a lead pipe. It is therefore quite similar to an insulated wire made in the United States some six or eight years ago in which the beads were of porcelain instead of wood; the porcelain had the advantage that the beads could be made large and have numerous holes, so as to contain a number of wires in the same lead pipe and insulated from one another. In the case of the Fortin-Hermann multiple wire cables each wire is first covered with its beads, and these are afterwards bunched and covered with lead, making, however, a rather bulky cable. The claims are that it is cheap, that the insulation is very high, and that the specific inductive capacity of the wooden beads is much less than that of porcelain, and that, therefore, the static capacity is very low, being, for underground wires, even lower than in aerial lines; and as the air enclosed in the lead remains unchanged, the insulation and capacity remain unchanged. It is used largely in Paris for underground telegraph and telephone lines, and has given very good results, particularly for telephone lines. The following data (reduced to miles), was given:

Insulation, per mile..................................	900 to 6,200 megohms.
Conductivity, per mile................................	10.3 to 18.9 ohms.
Capacity, per mile..	.068 to .060 microfarad.

The **Patterson** cables, included in the exhibits of the **Western Electric Co.** (United States section, Gold medal for collective exhibit), were, besides the Okonite exhibit, the only United States exhibit of cables containing many small conductors. They consist of groups of conductors, each covered with two or more windings of cotton or jute, or both, saturated with paraffine and protected by a pipe made of some composition resembling a lead alloy. This composition is said to withstand the action of water and gases underground where lead would be destroyed; it is harder and tougher than lead without being any less flexible. The space between the conductors and the pipe is filled with hot aerated paraffine free from any oil and introduced under pressure together with carbonic acid gas ($C O_2$). The almost invisible globules of gas scattered uniformly through the mass of paraffine render it elastic, so that the natural shrinkage of the paraffine in cooling is compensated for by the expansion of these globules, thus preventing the formation of cracks and longitudinal fissures through which water would penetrate indefinitely in case of a break in the pipe. Any flaw or leaking joint in the pipe is detected by the process of filling under pressure. The core may be made in lengths of 1,500 feet and the pipe in lengths of 80 to 140 feet. Another function of the occluded gas is to diminish the specific inductive capacity of the paraffine; it is claimed to diminish it 15 per cent. below that of pure solid paraffine, and this, they claim, enables them to use smaller conductors than if gutta-percha or rubber were used. This diminished size is claimed to prevent, to a large extent, troubles from "cross talk," due to the condenser action in the neighboring wires.

The current which leaks through the insulation of a cable has a tendency to produce chemical changes if any liquids are present. High insulation, therefore, diminishes this action by reducing the injurious current besides economizing energy. The paraffine used contains no oil which might have traces of acids or alkalies. Their cables vary from one-quarter to two inches in diameter, and contain from one to two hundred conductors in lengths up to eight miles, and are used for telephone, telegraph and electric light service. Some have the conductors twisted in pairs for metallic circuits.

From November, 1881, to June, 1889, they have made cables containing 86,727 miles of conductors, of which 22,313 are underground, and of which 36,927 are for telephone, 681 for telegraph, and 120 for electric lights.

The Okonite Co.'s (United States section, Gold medal) insulated wire is too well known to require description here. No technical data could be obtained from the company. The material, okonite, is reported to be a mixture of india rubber and mineral hydrocarbons. It appears to be placed around the wire in the form of a band with a longitudinal seam and adheres to the wire very tenaciously. An expert test made for the Jury showed an insulation resistance of 6,800 megohms per kilometre at 8° C. (4,200 megohms per mile), and a capacity of 0.36 microfarads per kilometre (0.58 per mile).

The Cobb Vulcanite Wire Co. (United States section, Gold medal,) exhibited electric light wire insulated with a moderately hard, but pliable vulcanized rubber tube, and with, or without, a lead armor. This tube is made of rubber the vulcanization of which is stopped before the rubber becomes as hard as the ordinary hard rubber, thus giving a material, the insulating properties of which are like those of hard rubber, and having the additional property of being pliable, so that it may be bent to a moderately small circle without injury to the insulation. The tubing is first made of soft rubber mixed with sulphur; by means of special machinery a seamless lead pipe is made around this soft tubing. It is then vulcanized under pressure by compressing the air in the tube, after which the stranded copper wire is threaded through lengths of about 200 feet of this tube, by means of a long steel needle, which operation is done quite rapidly by means of special machinery. The insulation is remarkably high, averaging, for a No. 4 or 5 wire cable, between 10,000 and 20,000 megohms per mile, and sometimes even exceeding 30,000. This is probably in part due to the fact that the tube fits the wire loosely and that it is therefore insulated to a great extent by the air between the wire and its insulating tube. This wire has been used in New York and Chicago for underground circuits.

CABLES.

M. Menier (French section, Gold medal,) one of the principal and oldest (founded 1850) French manufacturers, had a very fine exhibit of insulated wires and cables, chiefly of rubber and gutta percha insulation. This firm is one of the principal ones furnishing wires and cables for the French government (Telegraph and War Departments). The factory covers 5 acres of ground, employs 400 men and 1,000 horse power, using about 300 tons of crude rubber and gutta-percha, their business, including rubber goods, amounting to about $800,000 a year.

They exhibited a piece of their river cable laid for the government between Havre and Honfleur (on the opposite sides of the mouth of the Seine) 8½ miles long. It was laid in 1877 and is still in good condition. It consists of 5 wires insulated with gutta-percha, and protected with jute and a double armor of galvanized iron wire.

The underground electric light cables which they have made for Paris and other cities consist of tinned copper covered with three layers of vulcanized rubber, and covered with lead 2½ mm. ($\frac{1}{10}$ inch) thick. They claim to be the inventors of the double concentric cables.

Other creditable exhibits of cables were those of the **India Rubber & Gutta-Percha Co.** (French section, Gold medal), and **Fowler & Co.** (English section, Gold medal).

Henley's Telegraph Works Co. (English section, Silver medal,) exhibited samples of a large number of cables made and laid by them. Some of them were of interest historically. The earliest were: A single conductor cable laid at Ceylon in 1857, 30 miles, weight 66 tons; another in Egypt, in 1857, three wires, 9 miles and 20 tons; another in Tasmania, 1858, 240 miles, weight 408 tons. They were all of the well-known construction, with a galvanized iron wire armor, covered with a protecting compound.

The Commercial Cable Co. of New York, showed a model of a cable in which the armor was made of short iron tubes the ends of which were made so as to fit into one another, the joints being rendered air tight and elastic by means of thick round rubber rings.

MISCELLANEOUS.

Description of the Underground Wires for the City of Paris.—These cables are composed of wires of seven strands twisted together and covered with two layers of gutta-percha alternating with two layers of Chatterton compound. The cables are formed of 3, 5, 7 or 14 of these stranded wires bunched together, spun over with tarred cotton and covered with three layers, the first, of tarred jute, the second, of cotton tape impregnated with Norway pitch, and the third of tarred cotton tape wound in the opposite direction to the preceding layer. The diameter of the wire used is from .5 to .7 mm. (about No. 24 to 21 B. & S. gauge). The seven wires twisted together and covered as described above, are from 3.5 to 5. mm. diameter (equal to .137 to .197 inch). The copper has a conductivity of at least 90 per cent. that of pure copper; the resistance is not greater than 20.57 ohms per kilometre, (equal to 33.0 ohms per mile,) per square millimetre cross section at 0° C. Those most frequently used have the same resistance as iron wire of 4 and 5 mm. (.157 and .197 inch, or about No. 6 and 4 B. & S. gauge) that is, about 16 to 9.7 ohms per mile. For these the insulation is over 370 megohms per mile at 24° C. (75° F.) and the capacity is less than .48 to .40 microfarad.

Some others are covered with lead in place of the three layers of cotton and tape. These are used in the sewers or tunnels, being merely hung on hooks, while those without lead are put into cast iron tubes in trenches.

For long underground lines the cables are made like the preceding and are generally of three conductors of which two correspond to an iron wire of 4 mm. and the other to one of 5 mm. These are placed in cast iron tubes in trenches. Sometimes when there is only one cable it is covered with an armor of iron wire and simply buried.

The Société des Téléphones, Menier, India Rubber & Gutta Percha & Telegraph Works Co. (Paris) all furnish underground wires for the telegraph department of the city of Paris. For electric light underground cables vulcanized rubber is generally used in place of gutta-percha.

Description of the French Submarine Cables.—The conductor of the submarine cables is made of 7 strands of copper wire. This is covered with a layer of Chatterton compound and then with three layers of gutta-percha alternating with two of Chatterton compound. This is covered with two layers of jute wound in opposite directions, over which is then placed the armor of iron wire. For deep sea cables this armor of iron wire is made of small sized wires, while for shore ends it is made of large wires. For deep sea cables the armor is galvanized iron, while for shore ends it is an extra fine quality of iron wire known as "Best-Best"-quality. This armor is covered with three layers of bituminous compounds and two of tarred linen wound spirally around it.

The submarine cables used by France are almost exclusively made by the large English companies, namely, The India Rubber, Gutta-Percha & Telegraph Works Co., the Telegraph Construction & Maintenance Co. and the firm of Siemens Bros.

For "cable laying" see "telegraphy."

Cable Making Machine.—The Administration of Telegraphs of France exhibited a small model of the machines used by them at their factory for making cables. The bundle of insulated wires which are to constitute the cable are drawn slowly through a series of tubes in line with each other. Between the end of each tube and the beginning of the next, a layer of the covering material, be it insulation or armor, is wound around the cable from bobbins secured on a revolving disc concentric with these tubes. As the cable passes through, these coverings are thereby wound around it spirally and in alternately opposite directions. It also passes through tanks containing the liquid coating material and finally through a jet of cold water.

The following extract from the *Specifications for Galvanized Wire* for the French government, 1879 shows the requirements made and the tests to which the wire is subjected: The iron must be reduced and refined entirely with charcoal, and must be free from scale and other faults. It must be galvanized with pure zinc. Wires of 5, 4, 3, and 1 mm. in diameter must be able to stand a tension of 650, 440, 250, and 30 kilogr. respectively, with an elongation of not more than six per cent. It must resist being wound on a cylinder (size not given!) and subjected to a tension of 500, 350, 200, and 22 kilogr. respectively. The wire must resist being secured in a vise and being bent alternately forward and backward through a sharp right angle each way, 3, 4, 5, and 8 times, respectively. It must stand four successive immersions of one minute each in a solution of copper sulphate (one part to five parts of water) without being stained. The three larger sizes must stand being wound over a cylinder one centim. in diameter, and the smaller one over a cylinder of three mm., without detaching the zinc; but the wire will not be held strictly to this test. The wire must be made in France. In the specifications for 1889 the same conditions were imposed with the following additional requirement: The resistance at 0° C. reduced to a wire of one mm. diameter must not be greater than 156 ohms per kilometre (or about 250 ohms per mile for a No. 18 wire).

Testing.—For testing roughly cables and joints during their manufacture, it appears that the so-called plate, or influence machines (Holtz, Wimshurst, Carré, etc.) developing very high tension electricity, are coming into use largely in France. They seem to afford a ready, cheap and effective means to find whether the cable or joint is good or bad, without however enabling the insulation resistance to be measured thereby.

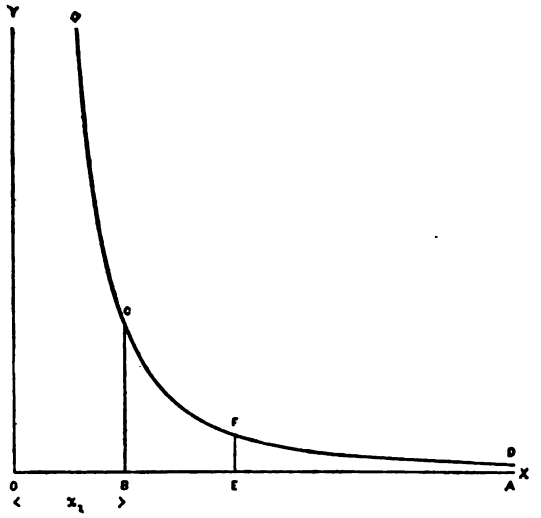
Splices.—**The Western Electric Co.** exhibited some splices of multiple wire Patterson cables, which were said, by some French experts, to be the finest they had seen. One was of 50 pairs, and others of 125 and 100 wires. The individual splices were distributed spirally over a short length of the cable and afterwards covered with a short piece of lead pipe only slightly larger than the other. They exhibited also some good, but somewhat complicated, splices for electric light wire cables.

ON ELECTRIC POTENTIAL AS MEASURED BY WORK.[1]

BY PROF. ALFRED M. MAYER.

The object of this paper is to give a demonstration of the fact that the potential, $V = \frac{Q}{d} = \frac{Q}{r} = \frac{Q}{C}$; when Q = quantity, C = capacity, r = radius in cms. of charged sphere, and d = distance in cms. of centres of two charged spheres.

It occurs to me that this problem could be presented in a direct and clear manner by supposing an electrically charged sphere fixed in space with its centre at O, (see figure), and that another sphere charged with a unit of similar electricity is pushed toward O from an infinite distance, along the line OX, and that the electric strain on the moving sphere causes (without work) a vertical rod to slide out of its top in proportion as the stress between the spheres increases. As the sphere progresses along OX it will thus mark at each point of its progress the repulsive force existing between it and the fixed sphere. The end of the sliding rod during the motion of the sphere from X towards O will have traced out the curve $DFCG$, whose ordinates are as the inverse squares of their distance from O.



Electric Potential as Measured by Work.

Thus we get a trace in a manner similar to that given by the steam-engine indicator, or by one of the many instruments which draw curves, showing the varying effects of pressures, or of stresses.

The potential at any point reached in the progress of the charged body towards O = work done = resistance overcome in pushing body from infinite distance to that point; and this work done is measured by the sum of the resistances at each point of path × the length of path. But this product is equal to the *area* included between the ordinate (say B) of the path, the axis of X and the curve, both indefinitely extended; or, say $CBAD$.

If the body has been moved from an infinite distance up to E, a certain amount of work has been done; and it is to be proved that if the body has been moved from infinite distance up to B, = ½ distance OE, that twice the amount of work has been done. In other words, it is to be proved that area $CBAD$ is twice the area $FEAD$; or, generally, that such areas will vary inversely as the distance of the bounding ordinate (such as FE or CB) from O, the origin of coördinates.

The equation of the curve is

$$y = \frac{a}{x^2}.$$

Area $ABCD$, indefinitely extended =

$$\int_{x_\prime}^{\infty} y\,dx = \int_{x_\prime}^{\infty} \frac{a}{x^2}\,dx = -a\left[\frac{1}{x}\right]_{x_\prime}^{\infty} = 0 + \frac{a}{x}, \therefore \propto \frac{1}{x}.$$

Or, area *indefinitely extended*, which represents the work, is inversely as the distance of y (the bounding ordinate of area) from O, or, $V = \frac{Q}{d}$; but also, $V = \frac{Q}{r}$, and as $V = \frac{Q}{C}$; $r = C$; r being expressed in cms.

I had supposed that the mode of presenting this problem and the demonstration based on that conception as given in this paper, must have ocurred to others before it did to me, but Prof. B. O. Peirce, of Harvard University, who is better versed in the literature of the subject than I am wrote me as follows: "My experience has taught me that students who have not paid much attention to mathematics almost invariably find it difficult to get any true idea of the meaning of the word "potential" and that they value highly anything which helps to make this meaning clearer. Your graphical illustration of the fact that in the case of two electrified spheres the potential function is a measure of work, is new to me and I feel sure that it will prove helpful to persons, who already familiar with indicator diagrams, are struggling to get an idea of the use of the potential function." The opinion of Prof. Peirce determined me to publish this paper.

It should be stated that Maxwell also used the indicator diagram in illustration of an electrical problem, though different from the one here considered. Section 27 of this work. "An Elementary Treatise on Electricity," is thus headed "*Indicator diagram of electric work.* The indicator diagram employed by Watt for measuring the work done by a steam engine, may be made use of in investigating the work done during the charging of a conductor with electricity. . . ."

Stevens Institute of Technology, Hoboken, N. J.

MEETING OF THE NATIONAL BOARD OF FIRE UNDERWRITERS.

The twenty-fourth annual meeting of the National Board of Fire Underwriters was held in this city on May 8, in the Mutual Life Building, president D. A. Heald in the chair.

The Committee on Statistics in their report said, with reference to the efforts made to obtain information from insurance companies as to their experience with certain risks: "An additional class was included in the request, namely, electric-light stations. The Committee was led to make the addition, as the hazard is comparatively new, and it was thought that if the figures in reference to it could be obtained for five years back, we should have practically complete results so far as risks of that character are concerned. The desirability of reliable statistics on the subject was also felt, as the electric light interest had used some satistics at the Niagara Falls Convention which were believed to be very partial, and to that extent, at least, misleading. Blanks were accordingly prepared as to the five classes herein named. Other hazards might as properly have been included, but, as stated last year, the effort was tentative. It was not deemed advisable to ask too much, or to include so many hazards in our blanks as to make it unlikely that companies could spare the clerical force necessary for the work. The Committee regarded its efforts as initiatory to future work, knowing that the field of inquiry could be widened whenever there should be evinced a sufficient interest in the matter to secure results of value to the contributing companies. That interest, however, the Committee has failed to awaken, as would appear from the fact that only twelve companies have responded to the request for the figures for 1889, and but two or three of these, as the Secretary reports, are companies doing an extensive business. In reference to the procurement of statistics of losses it is very much to be regretted that fire-marshal and patrol reports from various cities, are rendered useless as far as affording data of value to the underwriters is concerned, by reason of the absence of any information as to the value of the property directly involved in the loss. It would seem to your Committee that a simple ordinance requiring the Fire-Marshal or other official to obtain that information of every party sustaining a loss would be all that is needed to establish substantial data from which underwriters would be able to arrive at the percentage of destruction in any city."

In their report on lighting, heating, and patents, the Committee said with reference to electric lights and wires: "It did not take many months, however to discover that the electric light was not the harmless thing we had imagined, but that it was a most prolific source of danger, and its introduction has cost the insurance companies more than any method of lighting heretofore in use. It has come to stay, and some time it will probably be as safe as any light in use, but our knowledge of its properties and of its management must be vastly increased before that time appears. We see the danger, but as yet are too ignorant to point out the remedy. What yesterday seemed a safe method of installation to-day proves dangerous, and what we regard as safe to-day is likely to develop danger to-morrow. For a number of years the National Board has followed the action of the New York Board in the matter of rules regulating electric-light equipments. Those rules were revised and re-issued by that Board

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[1] *The American Journal of Science.*

[Read before the National Academy of Sciences.]

January 15, 1890, and it is recommended that they be adopted by this body as thus revised, and promulgated to members."

With the report a graphic diagram was handed in, which showed that, while electric wires and lights were responsible for losses of only $460,000 in 1886, the value of property injured by fire which could be traced to the same sources in 1889 was $5,533,000.

The Board agreed to adopt the rules of the New York Board in the regulation of electric light equipments, and appointed W. A. Anderson, Superintendent of Surveys of the New York Board, to meet a committee of experts at the invitation of the National Electric Light Association, to recommend rules which will make electric lighting safer all over the country.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Fire Department Underground Cables.—The Kemmler Proceedings. —Cable Road Litigation.

BIDS were opened on May 7th, at Fire Department Headquarters, for "Placing Fire Alarm Electrical Conductors Underground in New York City." The Standard Underground Cable Co. was the successful bidder at $47,771.59. The specifications include the furnishing and laying of 30,000 feet of two inch pipe and 650,000 feet of No. 14 conductor in "Standard" lead covered underground cables, braided and painted with "P. & B." paint. Work will be commenced immediately.

The Kemmler execution matter continues to excite interest, and will attract even more attention when the question comes before the United States Supreme Court, on the argument for a writ of error on May 19. To secure the granting of his application, counsel must show that a federal question was involved necessarily and essentially in the conviction and sentence of Kemmler. In the meantime, another writ of habeas corpus has been issued in the case of Kemmler, the murderer. The writ was granted by Judge Corlett and was obtained by Charles S. Hatch. It is issued to dispose of the question as to whether the warden of the state prison at Auburn, can legally execute. A stay of execution was some time ago asked upon the same ground, Mr. Hatch urging that nobody but the sheriff of Erie County could execute his client.

The Third Avenue Railroad Co. has again been refused permission to substitute cable for horse power. The General Term of the Supreme Court has sustained Judge Patterson in his opinion that the company's charter does not allow it to use cable power. Presiding Justice Van Brunt, who writes the opinion, says that the additional grant sought by the railroad company is contrary to the provisions of the constitution, which prohibits the imposing of additional burdens upon the streets without the consent of local authorities.

NEW YORK CITY, May 10, 1890.

PHILADELPHIA.

The Local Telephone Service.—Telephone Infringement Suits.

After the fitful fever of agitation, the telephone service of Philadelphia is improving. Chairman B. F. Andrews, of the Grocers' Investigating Committee, has received a large number of assurances from subscribers, orally and by letter, that the telephone company is doing much better in serving its customers. Mr. Andrews, with A. A. Keene, representing the Commercial Exchange; L. H. Lapp, of the Drug Exchange, and R. C. Lippincott, of the Lumberman's Exchange, called on President Merrihew, of the telephone company, recently. The delegation was cordially received, and assured that the company was making every effort to give Philadelphia as good service as any city. It was stated that the new building of the telephone company on Market below Fifth would be occupied about the 1st of October, when the wires would be underground in the business section of the city. As fast as the wires are put underground the metallic system will be adopted. The switch-board for the new building and system has been ordered to be ready on July 1, and will cost $100,000. President Merrihew stated that 154,000 miles of overhead telephone wires are strung in the United States, and 27,000 miles of underground wires. He cited as one reason for trouble with the service in this city the compulsory use of roofs instead of poles for the wires.

Summonses have been served from the United States Circuit Court in eight equity suits, brought by the Bell Telephone Company to have parties enjoined from using telephones alleged to contain infringements on the Bell patents. The defendants are the well known Thackara Manufacturing Company, John W. Stelwagon, John H. Rose, John S. Fanning, William B. Rambo, J. Rex Allen, John E. Morton, M. Lippman & Bro., Alonzo Hillier and James W. Queen & Co.

PHILADELPHIA, May 8, 1890.

BOSTON.

Legislative Notes.—Boston Electric Club.—West End Railway Work.

THE Legislature has been busy this week, considering various electrical questions, and has got through considerable work. The Meigs' bill, which had been favorably reported was finally re-committed and it will come up again for reconsideration, along with all other elevated railroad questions, on May 15th. The West End company have thus scored a point in the battle, as their bill will be reconsidered at the same time. The Meigs bill allows any street railroad to adopt that system, on permission of the city council of the city. The West End people will ask to have this permission made applicable to any system. In that event, the simple vote of the city council will permit them to elevate their tracks through the business part of the city, run their cars on them, and make the elevated a part of their surface system. The House appears to be friendly towards the West End bill, and if the West End bill goes through it will mean the death of the Meigs system, so far as Boston is concerned, for with the West End tracks elevated through the business part of the city, any independent system of elevated roads will not be thought of for years.

A bill has been reported to provide that electric light and power companies may mortgage their rights and franchises to secure payment of their bonds. A vote of a majority in interest is necessary; interest is not to exceed 6 per cent., and no bonds shall be issued to exceed the capital stock actually paid in.

The bill which has passed the State Senate and is now before the House, authorizing the consolidation of gas and electric companies is exciting a great deal of interest. It permits any gas or electric light companies in this state to combine by the vote of the stockholders, without any adequate guarantees against wholesale stock watering. The consolidated company is to appoint one appraiser, the commissioner of corporations another, and these two a third, who shall appraise the properties, and upon their appraisal fix the amount of stock that may be issued. In the House a communication was received from the attorney-general on the order of inquiry as to whether cities and towns have authority to construct and maintain within their own limits and for their own use, systems of lighting by gas or electricity; and whether they may sell gas or electricity for private use. The opinion of the attorney-general is that cities and towns have not such authority.

The Senate has passed to be engrossed the bill authorizing the Boston Electric Light Co. to increase its stock by $2,000,000.

At a regular monthly meeting of the Boston Electric Club, the proposed amendment of the constitution and by-laws was acted upon, and several important improvements accepted. Thirteen new members were admitted and very encouraging reports were made. The next monthly dinner of the Club will be held on Wednesday, May 21st (not May 19th, as on the bulletin) at the Parker House, when Mr. S. E. Barton, of the Electric Mutual Insurance Co., will read a paper on "The Relations between Fire Insurance and Electric Interests from the Underwriter's Standpoint." The change of date was made, so as to entertain the members of the American Institute of Electrical Engineers, who have their annual meeting in Boston, on the 21st and 22d of May. A formal invitation has been extended to the Institute, for as many members as may attend the meeting.

The West End Street Railway Co. are making arrangements to operate the Blue Hill Avenue line by electricity. In order to obtain more power quickly for the operations of their rapidly extending system the West End company will make arrangements with the Edison Illuminating Co., to rent about 1,000 h. p. from them for the summer time, which naturally is the slack period of any lighting company. Thomson-Houston generators will be installed and the Illuminating company will supply the power.

BOSTON, May 10, 1890.

CHICAGO.

A Plant for Cold Rolled Steel Wire.—Details of the Detroit Motor.

A COMPANY with a capital stock of $500,000 has been formed in this city for the manufacture of cold-rolled steel wire, and will at once construct an extensive plant. The patent for the only machine in the world for the cold-rolling of steel wire is said to be owned by this company and the prospects are considered good that an important industry will thus be built up at this point. The rolling of cold steel wire is accomplished with great ease under this process, and repeated tests have shown that the wire so produced is not only not weakened by the process, but, rather, that its tensile strength is nearly doubled. Thus, the tensile strength of hot-drawn wire is 56,460 pounds to the square inch, while that of the cold rolled steel wire runs up as high as 105,800 pounds. The machines to be used are the outgrowth of those invented a few years ago for rolling taper shapes, in which the wire to be reduced or tapered was subjected to the action of rolls grooved to conform to the taper desired. In working these machines it was discovered that steel wire reduced by this process was both softened and strengthened. Thus, the wire rolled by the new machine proves to be very malleable, it being possible to knot it, twist it and hammer it in a way the metal would not stand in its original condition, while a round, square, octagonal or hexagonal wire can be produced as desired. Another product of the machine is a cold-rolled copper wire with a steel core, produced by passing a steel bar through a copper pipe, which is then passed through the rolls. The ratio of diameters of the two metals is always maintained, showing that the rolling affects the metal uniformly throughout. A local corporation is negotiating for the exclusive right to manufacture this steel-cored copper wire for conducting electric currents, for which it is especially adapted, the copper furnishing the necessary conducting medium, while the steel core gives a much greater strength than it has been possible to obtain in copper wire. Experiments with steel, iron, copper, brass and german silver have given equally satisfactory results. The site for the new plant will probably be convenient to the river, and with a force of about 50 men it is expected that from 75 to 100 tons of wire a day will be made at the outset.

Mr. Armour, the representative of the Detroit Motor Co. in this city, is meeting with considerable success with these motors. They are very compactly built, and show solid mechanical construction throughout, and have a very handsome and tasteful appearance. The motors run without any sparking at the commutator whatsoever, thereby reducing expenses attendant on the wearing parts, of which the commutator is the most expensive, to a minimum. An ingenious switch is employed with these motors which may be said to combine in one piece of mechanism the switch, rheostat and magnetic cut-out. On the first movement of the switch handle the current is on, and by further movement the resistance coils are gradually cut out and finally the switch is maintained in position by a magnet energized by the current; if any cessation should occur in the current the magnet releases the switch which thereupon automatically retraces its way step by step over the resistance coil to the dead point. This action is obtained by a spring. This switch is a very useful adjunct to the motor as it practically takes care of the motor and prevents a burn-out and the machine when running requires no attention whatsoever, an important point when it is considered that motors are usually placed in the hands of anyone but experts and oftentimes receive the worst possible treatment.

CHICAGO, May 9, 1890.

ST. LOUIS.

City Lighting.—The St. Louis Exposition.—Electric Railway Work. Lighting at Lebanon, Mo.

The long expected electric lighting of the city is now an accomplished fact. Promptly at 7.30 P. M., May 1st, the 1,850 arc lights of the Municipal Electric Lighting and Power Co. were turned on. A few interruptions occurred during the first few nights, but everything is going on smoothly now.

E. V. Matlock, supervisor of city lighting, has submitted his first annual report and an estimate of the funds required by his department for the current year, of which the following is a summary :—

For lighting with gas or electricity public buildings not now lighted by electricity	3,275 00
ELECTRIC LIGHT.	
For lighting streets, alleys and parks	176,000 00
For salaries of supervisor, clerk and inspectors	8,500 00
For furniture, printing and stationery, apparatus, incidental expenses	3,300 00
For electric lighting of public buildings	38,000 00

The management of the St. Louis Exposition have engaged Mr. Fred. H. Whipple, of Detroit, to manage the electrical exhibit next fall. The exhibit will be made much larger and more varied in every way than last fall's display. Some of the novelties already booked are: Filtration of water by electrolysis, by the Stanly Electric Co., of Philadelphia. The Carpenter-Nevins Electric Heating Co., of Minneapolis, Minn., the Talmage Heating Co., of Kansas City, and the Burton Electric Heater Co., of Richmond, Va., will exhibit their improved heaters. The new Westinghouse Electric Railway Co. will have a complete power station and road in operation. The Electrical Accumulator Co., of New York, and the Edison Phonographic Doll Co., of New York, will make exhibits. Gold, silver and bronze medals will be awarded to all classes of electrical appliances. Mr. Carl Hering has been appointed by the American Institute of Electrical Engineers, and Mr. E. R. Weeks has been appointed by the National Electric Light Association to act as an awarding committee. A third member will be selected by the entire electrical fraternity, but his name will probably not be announced until July.

The Baden and St. Louis Railroad Co., a suburban road connecting with the northern end of the St. Louis railroad, have introduced a bill before the municipal assembly asking for the privilege of changing their motive power to electricity, either by overhead wire or storage battery.

The Forest Park, Laclede and Fourth Street Railroad and the Missouri Railroad (Market street section), have accepted the ordinances passed at the last session of the assembly, have filed bonds and will begin work immediately.

The East St. Louis City Council have granted an exclusive franchise to the East St. Louis Electric Railway Co., of which Henry D. Sexton is manager. The franchise authorizes the company to construct and operate four lines covering the important parts of East St. Louis. The capital stock of the company is $150,000 with the following incorporators, all of East St. Louis: Daniel Sullivan, Paul W. Abt, Edmund Wallace, C. T. Jones, H. F. Bader, Fred. Libar and Henry D. Sexton. In consideration of this franchise the company are to pay the city $5,000 in cash. The roads are to be completed in six months. Fare for all parts of the city five cents. The granting of this important franchise was something of a surprise. It was generally supposed that the St. Louis and East St. Louis R. R. would get the franchise.

The Lebanon, Mo. City Council have passed an ordinance granting an electric light franchise to B. F. Hobart, of St. Louis, for a period of 20 years. Both arc and incandescent lights will be used. The city agree to take 23 arc lights at $3,000 per annum, with the privilege of additional lights at $120 per annum. The franchise stipulates that Mr. Hobart and his associates are to erect a $100,000 hotel and bath house at the magnetic well. The ordinance is subject to a ratification by the citizens and an election for that purpose will soon take place.

ST. LOUIS, May 9, 1890.

PITTSBURGH.

Westinghouse Electric Company's Directorate—Western Union Standard Clock System Company—Electric Railway Work.

At a meeting of the Westinghouse Electric Company, which was held last Monday morning, the following board of directors was elected: Geo. Westinghouse, Jr., president; Henry M. Byllesby, R. Pitcairn, John Caldwell, J. R. McGinley, Calvin Wells and Chas. S. Pease. At the same time the Westinghouse Electric and Manufacturing Company held a meeting for a similar purpose with the following result: Geo. Westinghouse, Jr., president; Henry M. Byllesby, Robert Pitcairn, C. H. Jackson, G. W. Hebard, J. R. McGinley, Calvin Wells, H. R. Garden and A. M. Byers. Since that meeting was held the directors have called a special meeting of the stockholders to take place July 8, for the purpose of voting for, or against, an increase of the capital stock of the company. On that day the formal transfer of the business of the Westinghouse Electric Company to the Electric Manufacturing Company will also be made. The increase of the capital stock of the company is to be made on account of the fact of the company having entered into the manufacture of electric street railway appliances.

The Western Union Standard Clock System Company has been organized in this city for the purpose of supplying business houses and private residences with the correct time. Mr. J. G. Munson, who is in charge of the Western Union Telegraph office at the East End Stockyards is the manager of the company. He has just completed arrangements to give the correct time by wire from Washington, D. C. The time is to be transmitted every hour, all the clocks being electrically connected with the wire which runs from the Observatory in Washington. A number of clocks have already been subscribed for, and the company expects to have about 50 of them in operation by the first of June.

A limited corporation with a capital stock of $10,000, known as the National Electric Company of Wilkinsburg, has applied for a charter. Wilkinsburg is a small suburb of Pittsburgh. The new concern purposes to manufacture electrical appliances.

Over two hundred men are now daily employed on the line of the Duquesne Traction Company, engaged in putting down the tracks; and the management of the road have promised the Pittsburgh people that they will have their cars running by the first of October.

The North Allegheny Electric Railway Company has been organized, and the incorporators are pushing the work on the line as rapidly as possible. When finished this will make another feeder for the Pleasant Valley Electric Line, taking passengers from Pittsburgh across Allegheny City for several miles out the Perrysville Road. It will give strangers coming into Pittsburgh an opportunity to travel from the post-office direct into the very center of a busy petroleum producing centre. And all this can be done on the axles of the electric car.

An electric street railway is about to be built in Greensburg, forty miles from this city. The contract for a large part of the work was let the other day.

PITTSBURGH, May 9, 1890.

"TELEPHONE ENGINEERING."

Mr. J. J. Carty, the well-known electrician of the Metropolitan Telephone Co., of this city will deliver an address before the New York Electrical Society at Columbia College on Thursday, May 15, at 8.15 p. m., on the above interesting subject. It will be a practical talk on the various departments and details of telephonic work.

LETTERS TO THE EDITOR.

THE IRON-DIOXIDE OF MANGANESE STORAGE BATTERY.

[126]—Noticing in your issue of April 2, a secondary battery invented by one, Hollingshead, of Bronxville, N.Y., in which he claims the use of dioxide of manganese and metallic iron with an electrolyte having in solution an acid salt, I was led to experiment with the same, using for an electrolyte a five per cent. solution of bichromate of potassium and water. I used a porous pot in which I placed an iron plate and then filled the pot with dioxide of manganese, placing the whole in a glass jar for containing the electrolyte as above, and putting around the same a piece of sheet iron cut from a stove pipe.

I then charged the same with four acid batteries for half an hour, then discharged them through a bell having about two ohms resistance; the bell vibrated exactly three hours, I then charged the cells 10 minutes and discharged them through the bell for 57 minutes. I think this may be considered an excellent showing for the storage battery.

The surface of the negative plate of the cell was 70 sq. in. and the dioxide of maganese, which was the positive, consisted of 3½″oz. of crystals placed around the iron in the porous pot ¾″ x 2⅝″ x 4½.″ The pot was placed in a glass jar which holds about a pint of solution.

The electromotive force of the cell is lower than that of the lead battery but it has many advantages over the latter, some of which I wish to point out. Comparing the properties and action of the lead cells with the one under consideration we have:

Lead, Pb; atomic weight, 207; lead oxide, $Pb\,O_2$. The total quantity of oxygen in 5 pounds of the latter is 4,686.1 grains, and the *available* oxygen 2,443 grains. The weight of lead per cubic foot is 709.5 pounds. The number of molecules of water, $H_2\,O$, transposed in one reaction is 1.

Iron, Fe; atomic weight, 56; oxide of iron, $Fe_2\,O_3$. The quantity of oxygen in 5 pounds of the latter is 10,500 grains, and the *avaible* oxygen 3,500 grains. The weight per cubic foot of iron is 450.5 pounds. The number of molecules of water transposed in one reaction is 2.

The above comparison I have only made to prove that, to my mind, the iron battery is far ahead of any known lead storage battery.

The advantages it possesses over the other are lighter weight, and the absence of blistering, sulphating, buckling, together with the avoidance of acids and the continuous charging when first set up. Besides there is no danger of short-circuiting between the plates. It is cheaper in construction and more economical to use and requires no skilled attendance to take care of it.

There is no appreciable local action as, after using the same, charging and discharging it day and night for weeks, I weighed the plates and found them to be unaltered.

The only thing that might have changed was the solution. Some may be skeptical about the claims I make for this battery, but there is only one way to settle this point and that is to let them experiment with it. I believe this is the long-sought-for storage battery.

H. BLUMENBERG.

MT. VERNON, N. Y.

HAS KEMMLER BEEN ELECTROCUTED?

If the following circumstantial report of Kemmler's execution be true it is evident that the New York daily papers have been sadly left. We take it, *verb. et lit.*, from *The Weekly Sentinel*, of Port Arthur, Lake Superior, Ont., of Friday, May 2, 1890:

ELECTROCUTION.

PAINLESS DEATH OF MURDERER KEMMLER.

He Dies in Auburn Jail Without a Struggle—The Process Worked Well, as Death was Instantaneous—Scaffolds Will Soon Be No More.

[Special to the SENTINEL.]

AUBURN, N. Y., April 30.—The much talked of electrocution of Kemmler took place this morning in the presence of twelve reputable citizens, the jail surgeon and his assistant, the State electrician, the warden, turnkeys and others, and also of Rev. Dr. Houghton, pastor of the First Methodist Episcopal church. The condemned man was resigned to his fate and acknowledged its justness, saying that he sincerely repented for his crime.

There was no hitch whatever about the electrocution. The methodical regularity of carefully trained men served to make everything go smoothly. A procession from the doomed man's cell filed out early this morning led by Rev. Dr. Houghton. When the dismal procession arrived at the cell where the electric apparatus was constructed, Kemmler was quickly placed upon the death chair and pinioned so that he might receive the full shock. Then his spiritual adviser repeated slowly the words of the Lord's prayer, the doomed man repeating it after him. When he came to the words "For thine is the kingdom, the power and the glory," the electrician in charge of the apparatus touched the electric button sending the charge of over 7,000 volts through the chair and its unfortunate victim.

The sternness of Kemmler's features suddenly relaxed. There was just a visible shudder and that was all. None of the unmerciful contortions and stranglings and convulsions which mark the death of a man by hanging. Death was instantaneous. Everyone present was greatly relieved at the sudden termination of what they had forebodings would be a ghastly sight, and when in 11 minutes the jail surgeon pronounced life absolutely extinct, a sigh of satisfaction was distinctly audible.

This is the first death by the new process of electrocution. It is now to be sincerely hoped, as the system has been proven to be safe, quick and reliable, that there will be no more hangings. The days of the scaffold are almost at an end. The feeling is that if we must have an extreme penalty then that extreme penalty should be exacted only in the most modern and painless way. When a man must pay for a crime with his life, his life should be taken from him with as little brutality a possible.

LITERATURE.

Electric Light Installations and the Management of Accumulators. By Sir David Salomons, Bart., M. A. New Edition, revised and enlarged. New York: D. Van Nostrand Co., 1890. 334 pp. Price, $1.50.

IT is not often that the user of electrical apparatus has the time to devote to its intelligent and systematic study and this is all the more to be regretted as such observers are usually devoid of prejudice or bias and pursue the subject mainly for their own satisfaction and the benefit which may accrue to the others from their own experience. Sir David Salomons has long been known as an electrical amateur of far more than ordinary ability and his excellent little volume on the "Management of Accumulators," has deservedly had a large sale and has, perhaps more than any other book, served to give the student and the public at large a clear idea of the capabilities of storage batteries.

In the latest edition of Sir David's work are embodied the results of his most recent experiences, which go far to show that with the exercise of ordinary judgment and care, these batteries may be depended on for reliable service. It is fortunate that the author has had the advantage of ample means and facilities for carrying out his ideas and has gone about his work systematically, with the result that he is able not only to lay before the reader the best rules to follow for the management of accumulators from the time of their reception from the makers until they are in regular continuous service, but to discuss the important item of the cost and expense of operating a storage battery plant.

Recognizing also the desire of many non-professional persons and intending purchasers to be informed on the various apparatus in the market, the author has added several chapters to his original work descriptive of a large variety of details which go to make up a complete electric lighting plant. Although, naturally, the products of English manufacturers alone are described, the particular functions of each are so fully dwelt on that their description may be read with much profit by the American reader as well.

The work being intended more as a record of experience than a scientific treatise on the subject, a rigid criticism of it is superfluous. The errors that it embodies are not serious enough to require special mention.

It is written in a pleasing conversational style, is well calculated to interest and instruct those operating storage battery plants in particular, and is worth a baker's dozen of the average semi-theoretical books made up chiefly of principles that have never been tried and of practice that has well nigh been forgotten.

A SOLID ACCUMULATOR.

In a recent issue the London *Electrical Engineer* describes a dry storage battery in which the whole cell is much of the same consistency as a bathbrick, and can, therefore, suffer nothing by shaking. The modification mentioned is the invention and patent of Mr. Barbey-Starkey, whose name is so well known by his method of adding carbonate of soda to batteries to prevent sulphating. In the new solid accumulator the interstices between the battery plates are filled with a mixture of fine white wood sawdust soaked in the sulphuric acid solution and mixed with plaster of Paris. This mixture sets fairly hard and the whole cell is practically a solid mass. The cells have been tested experimentally by the Electric Traction Company at Barking, and it seems that, so far as the tests have yet extended, that the combination is very satisfactory. The internal resistance of the battery is not increased and the efficiency is the same, while the battery is only a shade heavier. A few cells have only as yet been tried, and the batteries have not yet been put to a practical working test.

REPORTS OF COMPANIES.

NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY.

The annual report of the New England Telephone and Telegraph Company for 1889 shows :—

	1889.	1888.	Increase.
Earnings	$1,255,570	$1,127,807	$123,263
Expenses	957,305	856,580	100,724
Net	$298,265	$270,726	$27,538

The company made liberal expenditures for betterments, charging more or less to expense account. Of the charges to new construction, $318,169.17, $190,000 has been expended for underground work, and $88,000 for extension of the extra territorial and toll lines. There were 124,405 feet of new cable placed in use in the Boston Exchange. The amount of underground wire in use at the end of the year was 3,599 miles, about two-thirds of the entire amount used in operating the exchange. No other city, except New York, has so much telephone wire underground. The company has now in use, in its various exchanges 446,470 feet of cable—aerial, submarine and underground—carrying 6,600 miles of copper wire. The company expended during the year for construction, $331,191 ; for re-construction, $106,956, and for repairs, $216,289, a total of $654,438, against $469,157 in 1888. The mileage of exchange wires December 31 was 19,784.

	Dec. 31, 1888.	Dec. 31, 1889.	Increase.
Exchange subscribers	15,536	16,719	1,183
Express subscribers	549	556	7
Private lines and agency stat's	2,847	3,178	331
Total	18,932	20,453	1,521

The increase of the number of stations during 1888 was 1,576. To effect the increase of 1,190 in the number of exchange and express subscribers, as shown by the foregoing statement, new subscribers have been connected, 4,731 ; subscribers disconnected, 3,541 ; difference, 1,190. The extra territorial lines number 76 ; miles of extra territorial pole lines, 2,180 ; miles of extra territorial wire, 5,048. Patent 413,276 was issued to the company on October 22, 1889, for "Central station calling apparatus," invented by Mr. Farnham. Applications have also been made for patents on a new form of underground cable covering and a double trolley crossing switch. The report deals with the interference with the telephone service of the electrice car lines and the efforts to diminish this interference. "Notice has been served as to operating, or indicating the intention to operate, the single trolley system upon their roads, in proximity to our wires, that the use of the electric current applied in that way is injurious to our business and an invasion of our rights, and that we shall hold them responsible for any damage to our interests resulting from that cause. It is the purpose of the management to employ such means as may be necessary to obtain relief from disturbance of this nature, and redress for the injury which we may suffer." The affairs of the company are declared never more prosperous. The estimated expenditures for 1890 are $350,000 for construction, $100,000 for reconstruction, and $650,000 for repairs. The net earnings were as above, say :

Net earnings	$298,265
Undivided earnings, Dec. 31, 1888	113,226
Total	$411,491
Dividends 1889	270,726
Balance	$140,765
Surplus account Jan. 1, 1889	373,525
Adjustment	11,250
Surplus account Dec. 31, 1889	$362,275

The balance sheet Dec. 31, 1889, was :

DEBTORS.

Licenses	$4,268,000.00
Plant	6,349,860.12
Unissued stock	1,605,400.00
Trustee stock	231,000.00
Stock and bonds	29,116.90
Construction (for the year 1889)	318,169.17
Office furniture, teams and tools	22,951.49
Bells, material and supplies	218,354.80
Accounts receivable	169,879.01
Cash	18,989.70
Total	$13,231,721.19

CREDITORS.

Capital stock	$12,000,000.00
Surplus account	362,275.72
Income account	140,765.27
Reserve account	153,213.23
Unpaid dividends	1,150.25
Bills and accounts payable	74,316.72
Loan of 1889	500,000.00
Total	$13,231,721.19

At the annual meeting of the company in New York these officers were chosen :— President, Thomas Sherwin ; vice-president, Henry S. Hyde ; treasurer, William R. Driver ; secretary, Fred. J. Boynton ; general manager, J. N. Keller ; board of directors, Fred. Ayer, Benjamin C. Dean, W. H. Forbes, John E. Hudson, Henry S. Hyde, A. O. Morgan, Moses G. Parker, Stephen Salisbury and Thomas Sherwin.

UNION TELEGRAPH AND TELEPHONE CO.

The treasurer of the Union Telegraph and Telephone Co. has presented the following quarterly statement to the directors at Lowell, Mass. :—

Gross earnings	$6,036.80
Gross expenses	4,960.23
Surplus	$1,076.57
Dividend No. 6	1,000.00
Surplus	$76.57
Surplus to Jan. 1	$1,072.80
Total to date	1,749.37

ERIE TELEGRAPH AND TELEPHONE CO.

The Erie Telegraph and Telephone Co. directors have declared a quarterly dividend of one per cent., to be paid by check mailed to stockholders, May 19, 1890, that are of record at noon, Friday, May 9. The stock books, on account of the dividend and the annual meeting, closed at noon, May 9, and will open Wednesday, June 11, 1890. The Cleveland Telephone Co., the Northwestern Telephone Exchange Co. and the Southwestern Telegraph and Telephone Co. report for the three months ending March 31, 1890, as follows :—

Gross income		$182,462.72
Gross expenses (including dividends payable May 19)		179,861.23
Surplus		$2,601.49
SUBSCRIBERS.		
Number connected Dec. 31, 1889	11,995	
Added during the quarter	250	
Total number connected March 21, 1890	12,245	
Proportion of dividends received by the Erie Telegraph and Telephone Co		$49,840.90
Dividend No. 26		48,000.00
Surplus		$1,840.00

OUTPUT OF BELL TELEPHONES.

The Bell Telephone output for the month ending April 20 was as follows :—

	1890.	1889.
Gross output	6,062	5,314
Returned	1,892	1,913
Net	4,170	3,371
Since Dec. 21.	1889–90.	1888–89.
Gross	18,881	17,803
Returned	8,042	7,619
Net	10,839	10,214

THE TELEPHONE IN MEXICO.

At the annual meeting of the Mexican Telephone Company, in New York on April 16, the old officers and board of directors were unanimously re-elected. Nearly 100,000 out of 168,000 shares outstanding were represented. The figures of operations for the year ended March 31 make the following comparisons :

Year March 31.	1889–90.	1888–89.	Increase.
Gross receipts	$68,190	$57,954	$10,236
Expense and construction	39,370	43,428	*4,058
Net	$28,820	$14,526	$14,294

*Decrease.

The instrument output was increased by 138 telephones, of which 100 were in the City of Mexico. The construction account showed a large increase, which in the City of Mexico increased $6,000. The five sub-stations showed increases in the construction account varying from $550 to $2,000. During the year $8,000 of old indebtedness left by former managements was paid.

Beginning with April 1, the publishers of **The Electrical Engineer**, New York, will issue that paper weekly instead of monthly as heretofore. The high position which the paper has always held in electrical journalism will undoubtedly be maintained, and the change will be a welcome one to the readers. We wish our contemporary the most abundant success in its progressive venture.—*Stationary Engineer.*

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Mr. R. W. Pope, the secretary of the Institute, has issued an important and interesting circular with regard to the annual meeting on May 20 and 21. The Institute has not held a meeting outside New York since 1884, when it held one in Philadelphia, at the time of the Electrical Exhibition, and there is every indication of a large and successful meeting in Boston, as the Institute has a large New England membership.

The annual meeting of the Institute for the election of officers for the ensuing year and the transaction of other business, will be held at the House of the American Society of Civil Engineers, 127 East 23d street, New York city, Tuesday evening, May 20. The rules require the election to be held in New York, but it is proposed to amend this so that it can be held wherever the annual meeting for the reading of papers takes place.

The terms of the following officers expire on that date in accordance with the Rules: *President*, Prof. Elihu Thomson; *Vice-Presidents*, Dr. Louis Duncan, Francis R. Upton, T. Commerford Martin; *Managers*, Dr. Schuyler S. Wheeler, Joseph Wetzler, Francis B. Crocker (Vice A. C. Fowler), John W. Howell (Vice Wm. Lee Church); *Treasurer*, George M. Phelps; *Secretary*, Ralph W. Pope.

The terms of the following members of Council do not expire this year:

Vice-Presidents, Edward Weston, Major O. E. Michaelis, (deceased,) Dr. Edward L. Nichols. *Managers*, Charles Cuttriss, George B. Prescott, Jr., Thomas D. Lockwood, William Maver, Jr., Dr. F. Benedict Herzog, Dr. Wm. E. Geyer, H. C. Townsend, Henry Van Hovenbergh (resigned). The vacancies caused by the death of Major Otto E. Michaelis, Vice-President, and the resignation of Henry Van Hovenberg, Manager, will be filled by Council.

After the conclusion of the regular business of the annual meeting, the following paper will be read:—"Electricity in the Navy," by Mr. Gilbert Wilkes, late of the United States Navy.

Upon the adjournment of the meeting the evening of May 20, those who intend taking part in the General Meeting at Boston, May 21, will re-assemble at the Grand Central Depot, 42d street, in time for the Shore line train for Boston at midnight.

WEDNESDAY MORNING.

The General Meeting for the reading and discussion of professional papers will be held at the "new building," Massachusetts Institute of Technology, corner of Boylston and Clarendon streets, Boston.

The morning session on Wednesday will be called to order at 10 o'clock.

The proceedings will be opened with an address of welcome by Gen. Francis A. Walker, Ph. D., L.L.D., President of the Massachusetts Institute of Technology.

After a response by the President, the following papers will be read:

"Electric Lighting in the Tropics," by Wilfred H. Fleming, of New York city.

"Magnetic Data of the Sprague Street Car Motor," by H. F. Parshall, of New York city.

"Note on a New Photometer," by Dr. Edward L. Nichols, of Ithaca, N. Y.

"The Limitations of Steam and Electric Transportation," by Oscar T. Crosby, of New York city.

A 1 P. M. a recess of one and a half hours will be taken.

AFTERNOON SESSION.

2.30 o'clock, Wednesday, May 21.

"The Industrial Utilization of the Counter Electromotive Force of Self-Induction," by Thomas D. Lockwood, of Boston.

"A Study of Arc Light Carbons," by Louis B. Marks, of Cornell University.

"The Practical Aspects of Alternating Current Theory," by Dr. Michael I. Pupin, of New York.

"Automatic Electric Welding Machines" (with Experimental Demonstrations), by Hermann Lemp, Jr., of Lynn, Mass.

Miscellaneous business.

WEDNESDAY EVENING.

The members of the Institute will be the guests of the Boston Electric Club at a dinner, the hour and place of which will be announced on Wednesday. A paper will be read under the auspices of the Club, by Stephen E. Barton, of Boston, on "Central Station Insurance."

The headquarters of the Club are at 7 Park street, where members will be welcome during their visit to the city.

The headquarters of the Secretary will be in Parlor E, on the office floor at the Brunswick, directly opposite the Massachusetts Institute of Technology. Other hotels in the immediate vicinity are the Vendome and the Thorndike. The Tremont, Parker House and Young's Hotel are within a convenient distance.

Transportation.—A special car will be provided on the midnight train from New York to Boston, May 20. The fare, including berth, is $6 one way. Those who desire accommodations in this car will please make early application to the Secretary, in order that all may be properly provided for. No remittance is necessary at present.

Members are requested to make their own arrangements direct for rooms at the Brunswick or such other house as they may prefer. The rates at the Brunswick are $5 per day, or $6 with bath.

A cordial invitation is extended to all persons interested in electrical progress to attend the sessions of the General Meeting, and New England members are especially requested to call the attention of their friends to this fact.

The thoroughly equipped Electrical and Engineering laboratories of the Institute of Technology will be thrown open for the inspection of all. It is also understood that one or two special excursions will be organized.

GLASS INSULATED WIRE.

According to recent reports, an inventor by the name of Thomas S. Reed has devised a conductor in which insulation is depended upon principally by a layer of spun glass. The method employed consists in first winding the wire with slack-twisted yarn, either cotton or woolen, and overlaying it with longitudinal strands of spun glass. Outside of these a strand of spun glass, intermixed with silk, is wound in a close spiral, and over that a braided covering of cotton, wool, hemp, flax, silk or fine wire. The whole is coated thickly with paraffin or thick varnish, if the wire is to be exposed to dampness. For that which is laid or buried under cover, soluble glass is used.

If the wire is to stand hard usage, all the glass strands are loosely twisted with silk, flax or other suitable fibre, before being applied. The wire can be glass-wound a number of times if necessary, but twice is generally sufficient. The first winding, which acts as a cushion, holds the glass strands in place, and the spiral row compresses them into an impervious surface. For extra security another spiral is wound the reverse way. The braided outer cover not only guards against the insulation's never slipping or cracking, but supplies a method of covering wires that is claimed to be practically indestructible.

THE MEASUREMENT OF ELECTRO-MAGNETIC RADIATION.

At the last meeting of the Physical Society of Berlin, Dr. Rubens spoke on the employment of the bolometer for observing the electrical radiations of Hertz as carried out by himself and Dr. Ritter. Up to the present it had not been found possible to measure the intensity of the radiation, owing to the extraordinarily minute amplitude of the oscillations; but the speaker had been able to carry out the determination by means of a special form of bolometer. It consists essentially of an accurately balanced primary Wheatstone bridge, two of whose arms are again converted into secondary Wheatstone bridges. If a current passes through one of them its resistance is altered by the rise of temperature, and the galvanometer gives a proportionate throw. A similar effect is produced by a wave of electrical radiation, and hence its amplitude can be measured by this bolometer when once it has been calibrated. When experimenting with the polarizing wire-grating it was found that there is a constant relationship between the intensity of the rays which pass the grating and the angle of inclination of the wires to the plane of oscillation of the rays. It was further observed that the energy which does not pass the grating is reflected, and to the extent of 98 per cent., when the wires are at right angles to the plane of oscillation.

THE TATLOW BATTERY.

This battery is composed of a zinc and peroxide of lead couple in dilute sulphuric acid. The peroxide of lead is obtained as follows: A lead foundation plate is filled in with a paste of lead oxides, made of red lead and sulphuric acid, or litharge and lead acetate solution—a plate, in fact, similar to an ordinary storage battery plate. When the paste has set hard the plate is placed in a solution of chloride of lime, whereby the salts and oxides of lead are gradually oxidized to lead peroxide, the rapidity of the reaction depending on the temperature and degree of concentration of the solution. It is absolutely necessary that there should be enough free lime present to keep the liquid alkaline. When completely oxidized the plate is taken out of the solution, well washed, and is ready for use in the cell, giving with zinc and dilute sulphuric acid an E. M. F. of 2 to 2.3 volts. After the plate has ceased to be active it is to be washed and returned to the hypochlorite solution. The same plate thus serves again and again, acting as a carrier of oxygen between the hypochlorite and the zinc. The reaction in the hypochlorite solution possibly involves the formation of a lead or lead-calcium hypochlorite during the process.

LEGAL NOTES.

HAND-OPERATED ELECTRIC GAS LIGHTING APPARATUS.

CIRCUIT COURT OF THE UNITED STATES, DISTRICT OF MASSACHUSETTS.

Electric Gas Lighting Co., *et al.*
vs. } *In Equity.*
Charles E. Fuller, *et al.*

COLT, *J.:*

This is a bill in equity brought for the infringement of letters patents No. 225,071, granted to Henry F. Packard, and No. 232,304, granted to Frank V. Sanford, for improvements in electric gas-lighting apparatus. The patents relate to that form of electric gas-lighting where the burner is operated by hand, and which does away with the use of matches.

Packard says in his specification:—

"My invention consists in certain novel devices, hereinafter fully described, by means of which the gas is turned on by pressing or pulling down and then releasing a lever fitted loosely to the stem of the cock, and thereby causing a vibrating arm to sweep past the tip of the burner; also, in the combination, with the said devices, of an electric contact-point fixed upon the end of the said vibrating arm, and of a fixed electrode located in close proximity to the orifice from which the gas issues, one of the said electrodes being insulated from the burner, and which, by the action of the said devices, are caused to make and break contact when the gas is turned on, thereby producing an electric spark and igniting the gas."

The claims relied upon are the third and fourth, which are as follows:—

"3. In combination with a gas-burner, A, and a fixed electrode, *n*, the ratchet, D, pawl *h*, spring F, lever E, pivoted loosely upon the stem of the cock and having two arms, *f* and *g*, to the latter of which is attached an elastic contact-point, and stop-pin, *k*, as and for the purposes set forth.

"4. In an electric gas-lighting apparatus, in combination with devices constructed and arranged to open and close the gas-passage to the tip at each alternate movement thereof, and conjointly with such opening to ignite the gas by an electric spark generated by such movement, devices which shall, without actuating the gas-cock, repeat the electrical spark by the return movement of the opening devices to their normal position for further use, substantially as described and shown."

The Sanford device is substantially like the Packard, with the addition of a chain which is attached to the arm of the lever. By pulling the chain with the hand, the burner is operated. The apparatus covering both of the patents is called the Packard-Sanford burner, and it appears to have been the first burner of this class which obtained any large degree of commercial success.

The defence mainly relied upon is that there was no invention in what Packard did, in view of the state of the art at the time. It is not denied by the complainants that every element covered by the claims of the Packard patent may have been old, but it is said that they were never so combined before, and that the result is a great improvement over all prior devices of this class. The complainants insist that it is by taking one element from one prior patent and another element from another that the defendants seek to destroy this patent, and, in answer to this position, they cite the reasoning of the Supreme Court in Parks *vs.* Booth, 102 U. S. 96, where, in stating the rule as to anticipation of a patented combination, the court says:—

"Where the thing patented is an entirety, consisting of a separate device or of a single combination of old elements incapable of division or separate use, the respondent cannot make good the defence in question by proving that a part of the entire invention is found in one prior patent, printed publication or machine, and another part in another, and so on indefinitely, and from the whole or any given number expect the court to determine the issue of novelty adversely to the complainant."

The constituents of the Packard gas-burner are a fixed electrode, a stop-cock with one way or several ways, a ratchet rigidly secured so as to move with the stem of the cock, and having four teeth for a one-way stop-cock, and a proportionably increased number of teeth according to the number of ways through the cock, an angle-lever fitted loosely upon the stem of the cock, one of its arms for operating by hand, and the other extended so as to carry an electric contact-point against and past the electrode fixed at the burner tip when the first arm is depressed, a pawl attached to the lever to engage with the ratchet, a spring to retract the lever when released after being depressed, and a stop-pin to limit the movement of the lever. To light the gas it is necessary to pull down the lever-arm once, whereby the pawl engages with and turns the ratchet which opens the valve and admits the gas through the orifice, while the other lever-arm sweeps past the contact-point across the fixed electrode, making and breaking the circuit and thereby producing an igniting spark; upon releasing the arm, the spring will return the lever to its position, making another spark on its return, and, the pawl not engaging with the ratchet on its return, the gas will be left burning. To extinguish the gas a single pull will revolve the plug so as to close the cock, and the spring will return the lever to its position.

No one of the prior devices, referred to by the defendants, discloses the combination of elements embraced in the Packard patent. Those devices at most contain but a part of the Packard mechanism, and, if practically operative, they seem to have been of doubtful utility. To have constructed the Packard apparatus and so made a practical and useful burner, I think showed invention.

The Smith patent, No. 20,305, shows a ratchet-wheel fixed to a gas-cock, a lever moving freely on the gas-cock, a pawl which engages the ratchet, and an arm carried by the lever to the tip of the burner, but it does not show that the teeth of the ratchet are proportioned to the ways through the cock; nor is the curved magnet of Smith pivoted at its centre and carrying a rod, the two-armed lever of Packard. The Smith arm is not carried past but only up to the burner tip, and from all that appears must be moved forward several times to turn on or off the gas. There are also other differences between the two devices.

The Tirrell patent, No. 232,661, bears a closer general appearance to the Packard apparatus. The date of the Tirrell patent is subsequent to the Packard, but it appears that the Tirrell invention was prior in point of time. But in the Tirrell patent there is missing the ratchet, the pawl, the spring and the stop of Packard. It is said that all Packard did was to apply the ratchet and pawl, which were old, to the Tirrell structure, and that this was not invention. But he did something more than this. We must take the combinations in their entirety, and so viewed I do not think the Tirrell invention destroys the Packard patent. It is clear that the Packard device is a great improvement over Tirrell's, and that the combination of elements employed is different. For the same reason and without entering into the specific distinctions between the two structures, the Heyl patent, No. 58,943, does not anticipate Packard. I find in none of the prior devices the combinations referred to in the 3d and 4th claims of the Packard patent, and, recognizing the prior state of the art, I think it called for the exercise of the inventive faculty as distinguished from mere mechanical skill to produce the Packard burner. Upon the question of infringement I have no doubt. Decree for Complainants.

The matter of electric gas lighting has been the subject of litigation for years. Two years ago A. L. Bogart, of this city, and the Electric Gas Lighting Co., of Boston, became joint owners of the patents in litigation, and proceeded jointly against all infringers. The above decision is the result. Preliminary notice will, we are informed, be served at once. As the matter now stands, only the above two concerns can manufacture these goods, and there is one licensee, who is also authorized to manufacture. It has now been established that electric hand-lighting gas-burners, having a fixed electrode, a ratchet upon the valve-stem, whose teeth are proportioned in number to the ways in the cock, and an angle-lever fitted loosely upon the stem, one arm for operating, and the other carying an electric contact point past the burner tip, a pawl attached to the lever and engaging with the ratchet, a spring to retract the lever when released and a stop-pin, and electric hand-lighting gas-burners having other equivalent devices for opening and closing the gas passage at each alternate movement, and conjointly igniting the gas by an electric spark thus generated, with further devices which, without actuating the gas-cock, shall repeat the electrical spark by the return of the opening devices to their normal position, are protected by letters patent.

ERECTING POLES WITHOUT CONSENT.

CITY OF NEWPORT, O. *vs.* NEWPORT LIGHT CO.

THE Court of Appeals has refused the Newport Light Company's motion for a re-hearing in the case of the city of Newport against it. This is a case where the light company erected electric light poles on the streets without obtaining the consent of the City Council, and the latter undertook to remove the same, when they were enjoined. The case was tried, and resulted in a verdict for the city. An appeal was taken, and the verdict sustained, and the above order ends the matter. Whether or not the city will now order the poles to be removed, is a question to be settled by Council.

EXCLUSIVE STREET RAILWAY RIGHTS.

AUGUSTA AND SUMMERVILLE STREET R. R. CO. *vs.* AUGUSTA, GA., STREET RAILWAY.

THE Augusta and Summerville Street Railroad company, of Augusta, Ga., claimed the exclusive right to all the streets for railway purposes under its charter from the legislature, and the ordinances and contracts with the city, and applied for an injunction to restrain the Augusta Street Railway company from building its electric road. The court held, without deciding the question of exclusive rights, that even if such existed they were applicable only to a street railway operated by animal power, and had no relevancy whatever to one operated by motor power, since the latter had been discovered and introduced subsequent to the date of the charter, ordinances and contract. The latter company has now in process of construction fifteen miles of electric road in the city and suburbs.

INVENTORS' RECORD

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued April 29, 1890.

Conductors, Conduits and Insulators:—*Method of Introducing Compositions into Electric Conductors*, D. Brooks, Jr., 427,039. *Electric Conductor Support and Protector*, E. M. Boynton, 427,221. *Electric Conduit*, G. Sprague, 427,445.

Distribution:—*Electrical Transmission of Power*, R. M. Hunter, 427,515.

Dynamos and Motors:—*Regulator for Dynamos*, W. H. Elkins, 427,163 and 427,164. *Commutator for Electric Motors*, A. A. Ingraham, 427,235. *Electrical Collecting Device*, G. Forbes, 427,259. *Dynamo Electric Machine*, DeW. B. Brace, 427,294. *Iron Core for Dynamo Electric Machines*, M. Deprez, 427,405. *Electric Motor*, L. Duncan, 427,503. *Electric Current Regulator*, E. P. Warner, 427,530.

Lamps and Appurtenances:—*Arc Lamp Attachment*, A. P. Seymour, 427,195.

Measurement:—*Alternate-Current Electric Meter*, G. Westinghouse, Jr., 427,489.

Medical and Surgical:—*Electric Dental Plugger*, W. E. Gibbs, 427,070. *Electric Galvanic Belt*, A. Dow, 427,468.

Metal Working:—*Method of and Apparatus for Making Rolled Forgings by Electricity*, G. D. Burton, 427,151.

Miscellaneous:—*Regulator or Rheostat*. Foree Bain, 427,082. *Magneto-Electric Machine*, C. E. Scribner, 427,122. *Electric Loop Switch*, C. E. Scribner, 427,123. *Apparatus for Testing Electric Lines*, B. E. Waters, 427,208. *Automatic Electric Switch*, M. A. Kissell, 427,237. *Gramophone*, W. Suess, 427,279. *Electric Locking Attachment*, H. J. Meyers, 427,341. *Electro-plating Bath for Copper*, 427,513. *Electric Switch*, O. S. Platt, 427,521, 427,522 and 427,523.

Railways and Appliances:—*Electrical Train-Signal*, G. D. Burton, 427,042. *Electric Connection for Brake-Hose*, W. F. Wamsley and T. McIntosh, 427,188. *Trolley*, W. F. Lewis, 427,333. *Power Transmitter for Railway Signals*, 427,361. *Railway Signaling Apparatus*, H. D. Winton, 427,387. *Electric Signaling System and Apparatus for Railroads*, C. H. Koyl and J. W. Lattig, 427,429 and 427,430. *Device for Unloading, Re-charging and Re-loading Electric Car Batteries*, J. C. Chamberlain, 427,459.

Telephones and Apparatus:—*Multiple Switch-Board for Telephone Exchanges*, M. G. Kellogg, 427,087. *Test-Circuit for Multiple Switch Boards*, C. E. Scribner, 427,120. *Divided Multiple Switch-Board*, J. J. Carty, 427,154. *Multiple Switch-Board Apparatus*, J. J. Carty, 427,155. *Telephone Exchange Apparatus*, J. J. Carty, 427,156. *Telephone*, J. C. H. Stut, 427,204.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"AT THE SIGN OF THE CLOCK."

In order to secure more room for their rapidly growing business in this city, the American Electrical Works, of Providence, R. I., have removed from 16 and 18 Cortlandt street, and have taken the first floor at No. 10 Cortlandt, "at the sign of the clock," immediately above the quarters of the Waterbury Clock Co. Mr. Phillips and Mr. Ackerman have been busy the last few days in getting things into shape, and the result is that they have laid out and fitted up a most comfortable and convenient range of offices. One feature of advantage, moreover, is that good elevator accommodation for the handling of wire packages in bulk is secured. The main offices and show room are in front, nicely fitted up in light woods. A cosy private office, whose walls are graced with pictures of successive clambake groups, is at the rear, and immediately behind that is a large store room capable of carrying a varied stock of all the excellent specialties and standard goods manufactured by the works. It may be mentioned that Messrs. F. W. Harrington and H. W. Bates have secured quarters for the Tropical Telephone Company on the same floor, thus constituting, in fact, another electrical centre in Cortlandt street.

President Phillips, while in town last week spoke very hopefully not only of home trade, but of the business that is being developed by the branch company in Canada. The results already obtained in Canada transcend his expectations, and the outlook is bright. The foundations of the enterprise have been made solid, and Mr. Phillips is more than satisfied with the magnitude and promise of the growing superstructure.

THE LITOFUGE BOILER CLEANING COMPOUND.

By this time, most superintendents of electric light and power stations have learned the desirability of keeping the boilers free from scale and the necessity of removing scale in case any should have formed; and the result is that an active demand has sprung up for boiler cleansing substances. A specialty that has lately attracted great attention in this line in America, is "Litofuge" made by the Litofuge Manufacturing Co., of 62 John street, this city. The Litofuge compounds are in the shape of an impalpable vegetable powder, and are distinguished by containing no fatty matter, acids, or chemical elements that might not only clean the boiler but in time leave no boiler to clean. These compounds are known as A. B. and C., and are disincrustant, anti-incrustant, and anti-galvanic. The first, of course, remedies the harm already done, by removing scale; the second prevents the formation of scale in new or clean boilers and the third protects boilers from the electrical action caused by the juxtaposition of iron and copper in their construction.

The proof of every compound, however, like that of every pudding, is in the eating; and the Litofuge company are in possession of many testimonials that go to show the "eating" qualities of the compound where scale and impurities held in solution are concerned. The following is one of the most recent:—

NEW YORK, April 30, 1890.

THE LITOFUGE MANUFACTURING CO.,
New York City.

Gentlemen:—

During the past year while superintendent of the Spanish American Light and Power Co., in the city of Havana, Cuba, whose electric plant consists of 4,500 incandescent lamps and 600 arcs with four 150 h. p. Hazelton boilers, I noticed that owing to the water in that city used for the boilers containing a large per cent. of magnesia and other substances, I was much troubled with the scale that formed in tubes and on plates, causing considerable expense for labor to clean the boilers, as well as deterioration of the boiler metal.

Since using your compounds, both A. and B., the result has been very satisfactory. The boilers now simply require washing, and the mud is taken out in the usual way. I made careful examination of the plates to see if they had pitted in any way, but could detect not the slightest ill effect.

I shall not hesitate in recommending your compounds where water is at all impure.

Yours very truly,
WILFRED H. FLEMING,
Member Am. Inst. Elec. Engrs.

Mr. Fleming has had considerable experience in engineering and electric light plants, and a long familiarity with the difficulties attendant upon station work. His testimony carries with it great weight.

NEW THOMSON-HOUSTON PLANTS.

The Chicago office of the Thomson-Houston Electric Co. sends us the following list of April sales:—

Arc. Illinois Steel Co., Bay View, Wis., 35 lights; Oakland Gas, Light & Heat Co., Oakland, Cal., 35 lights; Chicago Arc-Light & Power Co., Chicago, Ill., 50 lights; Capital Gas Co., Sacramento, Cal., 50 lights; Badger Electric Co., Racine, Wis, 50 lights; Terre Haute Electric Light & Power Co., Terre Haute, Ind., 50 lights; Aurora Electric Light & Power Co., Aurora, Ill., 35 lights; City of Chicago, Chicago, Ill., 70 lights; C. C. Travis, Tecumseh, Mich., 50 lights; New Omaha T.-H. Electric Co., Omaha, Neb., 50 lights.

Incandescent. Illinois Steel Co., Bay View, Wis., 50 lights; Standard Stamping Co., St. Louis, Mo., 250 lights; Denver Electric Illuminating Co., Denver, Colo., 650 lights; Marysville Electric Light Co., Marysville, Cal., 650 lights; Camden Electric Light & Power Co., Camden, Ark., 650 lights; Geo. Merritt & Co., Indianapolis, Ind., 100 lights; Swanton & Clark, Santa Cruz, Cal., 650 lights; Salt Lake Power, Light & Heating Co., Salt Lake City, Utah, 2,600 lights; C. C. Travis, Tecumseh, Mich., 650 lights.

WESTINGHOUSE WORK AND PLANTS.

We are in receipt of the following items of news from the Westinghouse Electric Co.:

Westinghouse alternating current apparatus for central station plants of a capacity of five hundred incandescent lights has been contracted for by a company which has been organized at Windsor Locks, Conn.

The Westinghouse Electric Company is highly elated at the reception its Shallenberger meter is receiving at the hands of the central station companies using the Westinghouse alternate current system. Ever since the meter was placed on the market its sale has been going steadily along. During the month of April meters to the capacity of almost fifty thousand lights were sold.

The Tesla motor is now to be introduced in the coal mines of the State of New York. The management of the Shawmut coal mines has just made a contract with the Westinghouse Electric Company for seven of these alternate current motors and one thirty horse power generator, this apparatus to be used in connection with the Hercules mining machine.

The electric light is constantly growing in popularity in the city of Elmira, N. Y. The illuminating company of that place, which commenced operations less than a year ago, has since that time been obliged to twice increase its capacity owing to the great demand made upon the light. The Westinghouse Electric Co., whose system of alternating current apparatus has been in use there from the first, received the third contract from the Elmira Illuminating Company a few days ago, and the company has now a capacity of twenty-two hundred and fifty lights.

It will not be long before from the cliffs of the island of Vancouver the electric light will shed its brilliant gleams upon the shimmering surface of the Pacific ocean. According to intelligence received a few days ago an electric light company has been organized at Vancouver, B. C , for the purpose of lighting up the city. The Westinghouse alternate current apparatus for central station plants has been contracted for by the Vancouver company.

Along with the other improvements which the Pennsylvania Railroad Company has inaugurated at Altoona, Pa., is to be added an arc light plant of ninety lights. An examination into the different existing systems of that mode of illumination decided the company to use the new Westinghouse arc light system, and the machinery will be immediately installed.

SMALL EDISON LAMPS.

The Edison Lamp Co. of Harrison, N. J., have just issued in "Catalogue E" a most interesting little pamphlet on the uses of their small lamps. In fact it is not simply a trade circular or price list but rises to the dignity of an instructive treatise on the subject. The value and the beauty of the small incandescent lamp have never yet been fully appreciated, and there remain many fields of ornament and utility in which it should find extensive employment. The pamphlet includes a section on batteries, and gives also some eminently practical instructions with regard to the manner of making a cheap "tumbler" cell, using "National" carbon pencils as carbons, so that singly or together they will maintain a lamp at full candle power for two or three hours. This simple battery is clearly illustrated. Cuts are also given of lamps for regular lighting circuits. At the end is a price list of the lamps, with cuts of the actual size, and a list of the agents and dealers from whom they can be obtained. On the covers is a long list of the Edison patents on incandescent lamps. The pamphlet is likely to have a very marked effect in stimulating the demand for such lamps, and we recommend our readers to secure a copy at once.

PARVIN'S LISTS.

S. H. Parvin's Sons, the well known newspaper advertising agents of Cincinnati, have sent us a copy of their new revised list of mechanical, trade and industrial papers. It comprises a number of prominent journals, and gives their size, time of publication, circulation, &c. There is furnished also a list of several of the manufacturing concerns who place their advertising through the Parvin agency.

C. C. SIBLEY & CO.

Messrs C. C. Sibley & Co. of 416-418 West 26th Street, this city, have completely equipped their new factory with the latest improved machinery and are now manufacturing electric lamps, motors, and general railway, telegraph, and other electrical supplies. They make a specialty of manufacturing for the wholesale and jobbing trade and dealers. Inventors just introducing their specialty will do well to correspond with them. Mr. C. C. Sibley has been actively engaged in electric manufacturing for several years past, and being seconded by Mr. F. G. Jahn, M. E., who is an expert in electrical matters, he purposes to do only the highest grade of work, at moderate prices. They are a pushing young concern and undoubtedly will succeed in whatever they guarantee or put themselves at.

THE NORTH AMERICAN CONSTRUCTION CO.

The North American Construction Co. of Pittsburgh has just completed the wiring of the new theatre at Worcester, 574 lamps having been installed. Mr. H. C. Hawks, the New England manager, has endeavered to make this a model theatre plant, and has every reason to feel satisfied with the results of his labor. Simplex braided caoutchouc wire has been used throughout, partly on insulators, and part being run through conduit tubing. The circuits were so arranged as to bring them to the back of the stage near the switch-board in easy reach of the attendant. The switch-board is of slate, and directly beneath are the handles by which to manipulate the Westinghouse stage regulators which are placed in the basement, thus taking up for electrical apparatus a minimum amount of space on the stage floor. Red, white and blue lights have been provided for the stage, and there are eight movable clusters of five lights with reflectors, for throwing light on the stage from the side. In order to make the plant as safe as possible the Westinghouse converters have all been placed in a fire-proof chamber in the basement. The current is supplied by the local company, and at the opening night the lights were turned on with brilliant effect, and complete success.

JAS. J. MURRAY & CO.

A representative of The Electrical Engineer had the pleasure, some days ago, of making a tour of inspection through the extensive glass works of Jas. J. Murray & Co., Philadelphia. This house manufactures and fills orders for arc and incandescent globes and shades in endless variety of size, shade and finish, besides keeping a large warehouse stocked with the principal sizes. It is truly wonderful to follow glass through the various stages of its manufacture from a canal boat load of sand, a car load of oil for fuel, a generous supply of water for steam, and a bucket of acid, to the incandescent shade etched with a dainty delicacy suggestive of lace.

Arc light globes of all descriptions and sizes are kept constantly in stock, and electric light companies are more and more appreciating the promptness with which their orders are filled and the merits of the goods themselves.

BALL ENGINES.

Owing to the growing demand for their engines, the Ball Engine Company, of Erie, Pa., have been obliged to increase their facilities and they are now building a foundry and moulding room.

DYER & SEELY.

This well known firm of practitioners, who have charge of so much of the Edison patent litigation business, have removed their offices from 40 Wall street to 36 Wall street. The firm is composed of R. N. Dyer, H. W. Seely, D. H.Driscoll and C. M. Catlin.

ST. LOUIS TRADE NOTES.

J. A. McClure has been appointed superintendent of motive power of the Lindell Railway, St. Louis.

Parrish Brothers and the Peck Electrical Company have opened an office in connection with the Southern Electrical Co. at 823 Locust St., St. Louis. Mr. D. L. Skidmore is in charge as agent.

The Interstate Gas and Water Works Company of St. Louis have filed official notice in the Recorder's office that they are about to extend their business, so as to include the erection, management and maintenance of electric light plants.

Mr. Charles Heisler, inventor of the long-distance system of incandescent lighting, has gone to Germany to rejoin his family. His daughter is to be married during this month to Herr Rudolph Buhl, a leading manufacturer of Edlinger, Grossherzogthum Baden. Mr. Heisler is expected to return in the fall.

NEW ENGLAND TRADE NOTES.

The Taunton Locomotive Works, of Taunton, Mass., have received orders from the West End Street Railway Company, of Boston, for 30 swivel trucks of a special design, to be used under the new long open cars, which are being built for the summer travel on the electric lines.

Johns-Pratt Co.—A factory for the manufacture of electrical insulators is to be erected by the Johns-Pratt Company at Hartford, Conn., and a second building has also been begun. The main structure will be a two-story brick building, 140 feet long on Capitol avenue and 40 feet wide. The other building, in the rear of the first, will be of brick, 90 feet long, 40 feet wide and three stories high. There will also be an engine and boiler house. Both buildings will be finished inside with Southern pine. Both buildings will be fitted up with electric lights throughout.

NEW ENGLAND TRADE NOTES.

Mr. Simeon E. King, assistant secretary of the Worcester Mutual Insurance Company (one of the Factory Mutuals), will temporarily take Mr. H. H. Fairbanks's place as secretary of the Electric Mutual Insurance Company.

The Electical Safety Company, formed to sell the Cartwright Protector, have sold their New England patent rights to the New England Electrical Safety Company, which will use the same offices in the meantime as the parent company. Mr. Hiram Simmons is president, Mr. C. F. Atherton, lately connected with the Thomson-Houston Electric Company, is treasurer and secretary, while these two gentlemen, with Mr. Mark Hollingsworth, will form the board of directors. The parent company retains the right to manufacture the protectors.

THE INTER-CONTINENTAL TELEPHONE CO.

The Inter-Continental Telephone Co. has sold all its rights, concessions, good-will and business in Venezuela to a very strong syndicate of English, Amsterdam and French capitalists for £30,000 as a going concern, with 1,250 subscribers, earning, all told, 7% net on $200,000, its full capital. The concession and business has been transferred with the approval of the Venezuela Government, and the new company undertake to extend the business throughout the country, and for that purpose have taken over the Tropical Telephone Co.'s contract, and already have expended about £6,000 for new instruments, switch-boards and line supplies, and stand ready to expend £4,000 or £5,000 more at once.

The Inter-Continental Telephone Co. received its original concession in 1883, which was approved by Congress and which was signed by President Guzman Blanco. A provision in the contract being that no similar concession would be granted to any other company. There are besides several later concessions and contracts made by the Government which cannot be annulled except by Congress. In the meantime, however, the Government of Venezuela did give concessions to the American Telephone Company consolidated, which sent representatives to that country, secured a few subscribers, and raised a large amount of capital in this country to push the business. This company was, however, effectually broken up by the Inter-Continental Company, and all the stock of the company was returned to the subscribers. The Inter-Continental Company, having now sold their rights to the English, it is safe to say that the Government will grant no more concessions to rival companies. "John Bull" will effectually protect his own rights, especially as there is already a large amount of English capital invested in Venezuela.

THE SPRAGUE PHILADELPHIA OFFICE.

We are advised by the Sprague Electric Railway and Motor Company, that they have temporarily discontinued their Philadelphia office, and that all business will hereafter, until further notice, be conducted directly from their New York Office at 16 and 18 Broad street.

THE GETHINS IMPROVED GRAVITY BATTERY.

The Gethins Electrical Manufacturing Company have issued a very interesting pamphlet on their improved gravity battery, which shows very clearly and conclusively the advantages to be gained by their method of dividing the two liquids into horizontal layers by their specially prepared porous cup. The Gethins battery continues to meet with the most pronounced success, and the company is recently in receipt of the following unsolicited testimonial, which speaks for itself :—

Police Department of the City of Boston,
Signal Service Office, A Pemberton Square.
April 17, 1890.

To the Hon., the Board of Police Commissioners :—

Gentlemen :—I herewith report that the Gethins Gravity Batteries placed in Station 10, Jan. 17th, 1889, were recharged with new elements of the same kind April 4th, 1890, having shown a constant service of 14 months, 18 days. As the service of a battery is in proportion to the work done, I would state that during that time there were received 2,857 wagon signals, 12,237 telephone signals and 198,486 "on duty" signals. As each signal will average 10 breaks of the current, this would indicate an armature movement of 2,131,160 times. As compared with the standard crow-foot battery, the best record in this service is 7 months, 23 days.

Respectfully submitted,
[Signed.] Henry A. Chase, Electrician.

NEW ENGLAND TRADE NOTES.

The Jordan Train Lighting Company has secured control of the Duralite Manufacturing Company, whose offices are at 85 Water street, Boston. Duralite is a wood pulp, or paper fibre, and can be made either fireproof or waterproof, or both, if necessary. It can be moulded into any desired shape, and is an excellent material for lamp sockets, buttons or any insulating piece of electrical apparatus. It will take a very high degree of finish, and comes out of the moulds with a beautiful glossy surface, as if polished. The Jordan Train Lighting Company will go into general electric construction work, comprising electric light and power construction, bells and burglar alarm work, and will carry a full line of electrical supplies. Among their specialties will be the Jordan mast arm, the Jordan train lighting apparatus and the Jordan automatic trolley-arm.

The Gould-Watson Company are in receipt of very large orders from all parts of the country for their well known moulded mica insulators, which can be made both water and fireproof. They have just completed arrangements to furnish insulators complete, with all the necessary metal fittings, so that electric companies can be supplied without having to send the castings to fit into the insulating compound. There continues to be a brisk enquiry for their goods from London and other European cities. Gould & Watson are also supplying large quantities of imported mica for all electrical purposes.

P. A. DOWD & CO.

The above firm, local agents for the Sprague Co., have closed a contract with the Newark Rapid Transit Co. for 16 cars and four 80,000 watt dynamos. They have also closed a contract for the Troy and Lansingburg Street Railway, for 10 open car equipments.

WESTERN TRADE NOTES.

The Illinois Anglo-American Storage Battery Co., who handle the well-known Sorley storage cells in the West, have removed their office from their old quarters, at 95 Dearborn street, to 177 La Salle street. Mr. W. D. McDonald is the manager of the company.

The Mather Electric Co. of Manchester, Conn., have obtained the contract for installing an incandescent plant in Hamsah & Hagg's new building in Chicago. This contract was carried off by the Mather people after a long and hard fight.

The Pumpelly Electric Storage Battery & Motor Co. have just installed a storage battery plant in Delavan, Wis.

The National Engineering Bureau, although of very recent organization, are getting lots of business and making tests and reports all the time. They make a specialty of this class of work, for which there is a large and continually increasing field.

Electric Watches. The latest novelty in outside watch signs for jewelers is the addition of electrically operated works placed in the interior of the old-time watch dummy. One cell of primary battery is employed, and the signs are made in large or small sizes and have a very striking and unique appearance. This device was got up by Mr. L. S. Grout, of 126 Dearborn street, Chicago, who is turning them out in large numbers.

Mr. William Hood, the Western agent of the Electrical Accumulator Co., of New York and the Electro Dynamic Co., of Philadelphia, has made arrangements to handle the new Walker meter, which was described very fully in our columns recently. This sensitive and delicate instrument registers by means of a photographic record and thereby attains remarkable accuracy.

Mr. Huntington Lee, of the Fred. H. Whipple Co., of Detroit, who is now in Chicago looking after the business of his house, was a caller at this office. He is particularly busy in making arrangements for the coming electrical exhibition at St. Louis, of which Mr. Fred. H. Whipple is the general manager. Mr. Lee will assist him and take charge of the construction work and in such hands the work will be carried out with credit to all concerned.

The Excelsior Electric Co., who have been located at 11 East Adams street have, owing to the rapid and constant increase in their business, been compelled to secure new and more commodious quarters in the Rookery Building. This is fast becoming Chicago's electrical centre, and already numbers many of the prominent electrical companies among its tenants.

Visitors at the Chicago Electric Club last week were Mr. G. M. Peters, Cincinnati; T. B. Brown, Kansas City; C. M. Peck, Cincinnati; W. H. Lukins, Streator, Ill.; W. H. Gillett, New York; Ely E. Ware and Charles Ware, Cedar Rapids; E. D. Stiles, W. A. Stiles, A. K. Stiles, Chicago; Jas. F. Cummings, New York, who is interested in a large Edison plant which is to be installed in Milwaukee right away.

The Hawkeye Electric M'f'g Co. of Davenport, Iowa, have installed 11 of their motors in St. Joseph. The latest put in is one of 10 h. p. capacity, at John Armstrong's coffee house on Edmond street. The Union Railway Co. is furnishing the necessary power.

Mr. Geo. E. Clow, 57 S. Jefferson street, Chicago, is making a specialty of cut-outs and switches for electrical purposes and turns out some very fine work. He has recently increased his facilities and is now able to cope with any quantity of business in the line. He puts the finest mechanical workmanship throughout into his goods, and is enjoying a well earned reputation thereby.

"Electrical Industries."—Our esteemed contemporary, *Electrical Industries*, has removed its offices in the Rookery, which were located in room 304, to more comfortable quarters in room 351, in the same building. They now have very handsome and convenient quarters and considerably more floor space than before.

Mr. Frank B. Rae, the electrical engineer of the Detroit Electrical Works, was in Chicago for several days last week, and devoted all his available spare time to the Club and the clubmen.

Mr. W. A. Jackson, manager of the Michigan Telephone Co., was a visitor at the Club on Saturday.

Mr. M. A. Knapp, the manager of the Knapp Electrical Works, has gone east on a business trip and expects to be away from the city for about a week. He will visit Detroit, Pittsburgh, Hartford and New York.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada,	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, MAY 21, 1890. No. 107

The great development in electricity will be, I am firmly convinced, in discovering a more economical process of producing it.—T. A. Edison.

POWER PROFIT vs. LIGHT PROFIT.

IT is not at all unlikely that some of our central station readers have sat down now and then and tried to figure out for themselves the different returns obtainable from current sold as light and current sold as power; but we are, nevertheless, inclined to believe that local lighting companies as a rule have not yet begun to treat the power question as it deserves, taking it up seriously and giving the electric motor a fair trial, as the basis of a large and legitimate business.

While we would be the last to disparage the excellence of the opportunities presented by electric lighting as an industry, we do not hesitate to express our conviction that electric power is, if anything, superior to it, as productive of a return upon the capital invested and the care required. Where the two industries are intelligently conjoined in the one plant, the superintendent may rightfully feel that he is making the most of his chances—but not till then.

Let a station superintendent who has never done so before give a spare hour. or two to an inquiry into the amount of power used within the area covered by his circuits, as well as the amount he could dispose of if people knew that his motors were available. He will be surprised at the result. The aggregate of elevators, sewing machine gangs, coffee mills, ventilating fans, ice cream freezers, printing presses, and other apparatus needing power through the day and night would prove respectable enough to warrant the running of a power circuit in any place above the level of a village, and blessed with a good central station.

Let the superintendent also, during the spare hour that we have so freely assumed him to have at his disposal, make a little calculation as to what the current will bring him in per horse power in light, and per horse power in mechanical energy. Thus, for example, say he is getting $100 per year for a full arc light. Against that he has to charge in the neighborhood of $10 for carbons, and the services of the trimmer, as well as breakage of globes, etc. How much will he get for the same horse power in motor service, less the charge for carbons and with certainly a much lower charge for attendance? The calculation on the basis of either arc lighting or incandescent lighting is well worth making, it being borne in mind that with the power subdivided in small motor units, the very fullest generating capacity of the plant can be sold.

And then there is the question of street car operation. Why should a superintendent whose blood is warm within him, sit still and see the street railroad in his town plod along with horses, when he can supply current for a modern electric service that will stimulate, and boom, and brighten up every interest in the locality? Here again let the calculation as between power and light be made, with the idea of exacting from the station investment the best return of which it is capable. We do not think the hesitation to occupy the field would last very long.

FURTHER EDISON CONSOLIDATIONS.

IF the rumors that are faintly heard as we go to press be true, and there seems good reason for entertaining them as pretty nearly correct, considerable changes will shortly be made in the management of the vast Edison manufacturing interests. It will be remembered that when the Edison consolidation was effected about a year ago, the intention was to have all the manufacturing and sales departments under one control, and it would appear that the new programme simply develops that plan to its natural conclusion, rounding out the whole scheme of organization. The reports to which we refer go so far as to associate the name of Mr. Samuel Insull, who has long been actively engaged in the direction of the Edison Machine Works and other branches, with the oversight or management of the whole new amalgamated department, and it certainly would not be very surprising if he were selected. While we cannot say that we have been able to confirm these rumors in their entirety, the signs are that they hit near the mark, and we give them for what they are worth. Probably in a week or two, further news will be obtainable with regard to this notable change of such great importance, a change which, if we do not misunderstand it, means that the Edison General Electric Company will, in its own name, direct and control from its headquarters in New York, all the Edison manufacturing and sales interests now scattered throughout the country under a variety of titles.

THE CARBON BRUSH.

IN the early days of the dynamo and motor when the magnetic proportions of armature and field were not so well understood as they are to-day, the trouble caused at the commutator was of frequent occurrence, and to such an extent even that not a few set about devising means for avoiding its use altogether. Though this difficulty disappeared in a great measure in later and more correctly designed dynamo-electric machinery, its removal may be said to have been entirely accomplished by the application of the carbon brush in the stead of the copper strips. Indeed, looking at it from our present standpoint, and more especially with reference to electric railway work, there is hardly one detail which has contributed more to the successful operation of the electric motor than this. While the importance of this improvement may not be so apparent in its application to stationary apparatus, which can be inspected and regulated at any time, it assumes immediate prominence when applied to a motor under a car, subject to every adverse condition of operation. We are led to these observations by the recent issuance of a broad patent covering the use of the carbon brush which has just been granted to Prof. George Forbes, of London, and which, in view of the extended application of the carbon brush at the present time may be looked forward to as the basis of probable future litigation. We print the claims elsewhere. We publish in this issue also the description of a type of carbon brush due to Mr. Leo Daft, in which the heat resisting and wearing qualities of carbon are enhanced by the addition of plumbago as a lubricant. The success which has thus far attended the employment of the carbon brush on street railway motors makes it fair to assume that it will in time find general employment in stationary work also, and that further improvement may be looked for.

ALTERNATING CURRENTS AT HOME AND ABROAD.

We print elsewhere an extract from an interesting letter by Mr. R. E. Crompton, which throws considerable light on the differences which exist in the application of the alternating current in this country and abroad, and more especially in England. Mr. Crompton has recently installed an alternating current plant after having been, and still continuing to be, a strong advocate of low-tension distribution in conjunction with storage batteries. He shows the reasons for his action, which coincide with what may now be said to be the general opinion of competent electrical engineers. Lighting abroad is confined principally to private dwellings, in densely populated districts, and where as a rule a single dwelling is normally burning but few lights it is wired for a large number, which may be required at more or less frequent intervals, and in which converters would for a large part of the time be working at a very light load. Mr. Crompton also points out the interesting fact which is sometimes lost sight of, that under the conditions imposed, the cost of the underground system in London is almost independent of the weight of the copper conductors, which are only a small percentage of the whole outlay. Mr. Crompton admits, however, that where the lighting is scattered the alternating system has many advantages, especially where overhead conductors can be employed. The consistency of Mr. Crompton's action is therefore apparent, and he proves that the success attained by him in his Kensington and Knightsbridge districts in London in connection with storage batteries has left him unbiassed where the conditions of distribution are different from those obtaining there.

COPPER IN THE TARIFF DEBATE.

Mr. Butterworth, of Ohio, treated the House and the country to a sensation, May 13, by a ringing speech in the tariff debate, attacking the McKinley bill in the house of its friends and promoters, forcibly exposing its inconsistencies and its humbug as a measure of tariff reform, from the point of view of an earnest protectionist. Illustrations of these qualities, in plenty, were ready to his hand in the text of the bill, and he made good use of them. Among them was the copper schedule. The McKinley bill would reduce the duty on ingot copper from four cents per pound to two cents, and leave untouched the duties of thirty-five per cent. on plates, sheets and rods, and forty-five per cent. on wire. Mr. Butterworth said:

> Will you tell why the duty on copper should be continued? Why not make copper free to all the people who are using it in this country? Do you not know that every electrician in this country petitions to remove the duty on copper? Is it necessary to protect this industry? Is it an infant industry?
>
> * * * * * * * * * * * *
>
> There is no apology in the world for the duty, not the slightest. It does not protect any industry, but it draws on every family we represent. There is not a yard of wire, not a piece of copper in any household in the land that does not pay tribute. * * *

Mr. Butterworth's strictures were mainly directed to the duty on ingot copper and its abuse by the copper mining companies. After pointing out that American copper had usually been sold in foreign markets at lower prices than in our own markets, he continued:

> Nor is that all, Mr. Chairman, but having control of the copper market in 1887, they organized a combine by which the supply of American copper had to go back to American homes, sifted through the mercies of a French syndicate.

Mr. Cannon, of Illinois, entered the discussion to express his belief that no necessity existed for a tariff on copper. In the course of his remarks he recited an incident that indicates the motive of the copper men in seeking to retain a duty on ingots. Said Mr. Cannon:

> I said to a man who has great copper interests, but yesterday, when he said that he himself had suggested the cut on copper one-half from the present law: "But why not carry it further and cut it all?" He said frankly: "I think that it could be done, but conditions might arise in the future where it would be embarrassing to the industry."

There's where the rub comes. Free copper might easily be embarrassing to the promoters of combinations for restricting competition and keeping up prices. It is not easy to conceive how it could otherwise "embarrass the industry" while this country produces a surplus of copper for export, and while we have the word of leading mine owners that they can produce the best metal in the world and lay it down in New York at 6 to 7 cents per pound.

The Washington Navy Yard Plant.

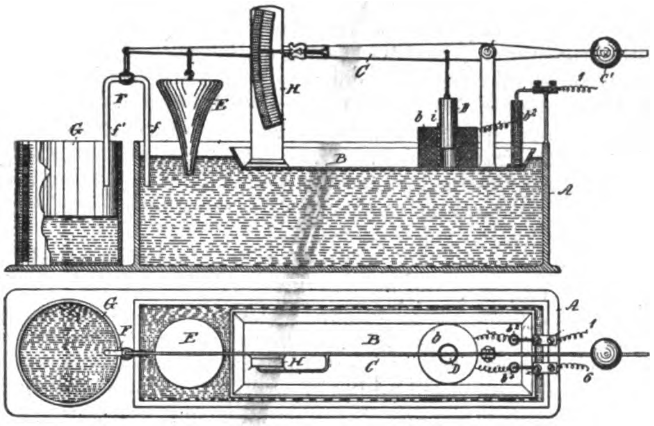
The high standard of excellence and efficiency set by the United States Naval authorities in electrical work is familiar to our readers, some of whom may be excused for thinking that now and then the requirements have been a little too exacting. Still there is a pleasure in seeing the standard maintained, and we are glad to be able to illustrate this week the beautiful Brush plant installed at the Washington Navy Yard, where it has met the most onerous conditions with perfect satisfaction. Aside from being a model of its kind, the plant is also interesting as the first shore installation put in for the Navy. We invite attention to Ensign Wilkes' careful article, and venture to express the hope that such plants may speedily multiply.

CURRIE'S ELECTRIC METER.

The general demand for electric meters has resulted in the designing of a large number of them, depending upon a variety of principles, including the magnetic, heating and chemical actions of the electric current. That this field is not yet exhausted, however, is evidenced by a recent adaptation due to Mr. S. C. C. Currie, electrician of the United Electric Improvement Co., of Philadelphia. This novel meter embraces in its construction the action of the current upon a magnet, as usually employed for such purposes, which in turn controls the quantity of liquid passing into a vessel, so that the measure of the liquid serves as a means of determining the amount of current which has passed during a given time.

The manner in which this is effected is shown in the accompanying engraving (Figs. 1 and 2), which represent respectively a plan and section of the apparatus.

It consists essentially of a tank, A, filled with a liquid, and in which is placed a float, B. Upon the latter is mounted a solenoid, *b*, which is placed in circuit with lamps by means of wires, 1 and 6, which dip into the long mercury cups, b^2 and b^3. The lever, C, carries the core, D, which is under the influence of the solenoid, and also a float, E, which dips into the liquid. At its extreme end the lever carries a siphon, F, the two legs of which dip, respectively, into the liquid in tank, A, and into the vessel, G. There is also provided a scale by which the strength of the current passing at any time can be read off directly.



Figs. 1 and 2.—Currie's Electric Meter.

For the operation of the meter, the tank, A, and the tube, F, are filled with a liquid, such as acidulated water, and the oscillating lever, C, is so adjusted by means of the counter-weight, c', that the end, *f*, of the siphon will extend a short distance, say one-eighth of an inch beneath the surface of the liquid in the tank, A, in which position the acidulated water will not be siphoned from the tank into the vessel, G. The tube, F, is previously filled with liquid by suction, and placed in position with the end, f', extending into the vessel, G. A tube with a very fine bore is employed because the liquid will remain in the tube even when raised entirely above the surface; and also for the reason that when one end of the tube is immersed a short distance, say a quarter of an inch, into the liquid, the latter will not flow at the opposite end; that is, of course, assuming that the two legs of the siphon are of equal length. This is due to the fact that the pressure or head is not sufficient to overcome the capillary attraction, and hence the first readings from the zero-point commence from a point slightly below the surface of the liquid. This is of considerable importance, for the reason that the tube need never be raised entirely out of the liquid, and consequently never emptied.

It will thus be seen that according to the strength of current passing through the solenoid, *b*, will the plunger, D, and consequently the tube, F, be proportionally lowered; and hence the amount of the fluid which will flow in a given time from the tank, A, through the siphon, F, into the vessel, G, will be dependent upon the current through the coil, *b*. At the same time the strength of the current flowing at any moment may be observed by the pointer on the dial.

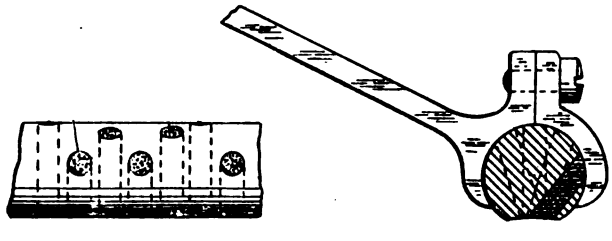
The attraction on an iron core by a solenoid will not alone cause the various depths of immersion of the siphon, F, so as to cause the flow of the liquid through the same, consequent upon the variations in the "head," to give absolute proportions, and hence, in order to obtain the desired absolute proportional results, the displacement-float, E, is suspended from the lever, C. The shape of this float is such that the resistance exerted against the downward movement of the lever by its displacement of the liquid is so proportioned at the various depths, that the immersion of the siphon, and consequently the flow of the liquid through it is exactly proportional to the amount of current passing through the solenoid.

During the operation of the meter the float, B, sinks farther into the tank, A; but the contact from the circuit through the coil, B, is maintained by means of the wires dipping into the mercury-cups b^2 and b^3. By this arrangement if by accident or neglect the water should sink below a certain level the circuit will be automatically broken and the lamps in the circuit extinguished.

It is evident that by measuring the quantity of water which has passed by drops from the tank, A, into the vessel, G, in a given length of time the quantity of electricity which has traversed the meter in that time may be at once ascertained. For that purpose the scale, *g*, is so graduated that the height of the water as indicated will represent the number of units of electricity that have passed through the meter in a given time.

DAFT'S CARBON BRUSH.

The great durability of carbon due to its heat resisting qualities, has led to its general adoption as a contact for commutators, especially on those employed for electric railway work. Pure carbon alone, however, while having great heat resisting properties, has but very little lubricating qualities, and hence some means of combining both qualities in one is desirable. This has been recognized by Mr. Leo Daft, who has recently devised a form of "brush" or contact which is illustrated in the accompanying engravings. It consists of compressed, ground, cemented gas-retort carbon, in which are inserted pencils of plumbago having their ends projecting at the wearing surface The surface-contact is generally ground to a circle, as shown, so as to leave a sufficiently large contact-area and permit equal pressure over all its surface, so as to prevent sparking. Instead of inserting the plumbago in pencils, the powdered plumbago may be mixed with powdered carbon, in the proportion of five to fifty per cent., using coal-tar or molasses to hold the mass together during baking. The object of this combination is to form a conductor of a substance of high conductivity and great lubricating power, so as to reduce the wear of the commutator and increase the smoothness of its operation. Where it is desirable to secure a perfectly noiseless machine for light running purposes, Mr. Daft finds it beneficial to incorporate one to two per cent., by weight, of finely powdered silicate of magnesia in addition to the plumbago.



Daft's Carbon Brush.

DR. LODGE'S LIGHTNING ARRESTER.

In our last issue we gave a description of a new form of lightning arrester devised by Dr. Oliver J. Lodge, and based on the principle that the lightning discharge is forced to jump the air gaps to earth by the interposition of inductive resistances.

We are now enabled to illustrate the actual apparatus as constructed by Dr. Alexander Muirhead. The engraving,[1] Fig. 1, shows it in perspective, and Fig. 2 is a diagram of the connections. The central boss, it will be noted, is connected to the brass case by means of a rod down the centre. Underneath, in the base of the instrument, is a screw to which a direct connection with the earth is made. The screw on the central boss at the top is only used when a handy earth is wanted for an instrument. The first projecting rod is of platinum, the second of brass, and the remaining three are of copper. This arrangement, it will be seen, is equivalent to that shown in our issue of last week, with the lower row of coils omitted.

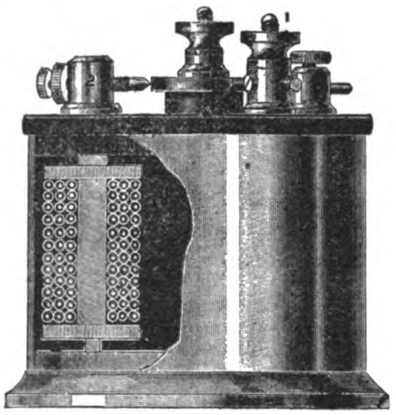


Fig. 1.—Lodge's Lightning Arrester.

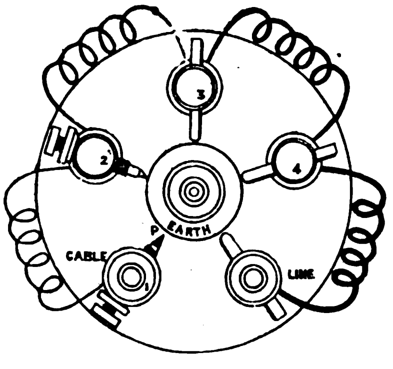


Fig. 2.—Lodge's Lightning Arrester.

The self-induction of the coils is inappreciable for ordinary currents and they contain no iron cores. The superiority of this device over ordinary single air-gap protectors, at any rate in the case of powerful discharges from a large Wimshurst machine, is said to be most marked.

RESISTANCE WIRES IMMERSED IN LIQUIDS.

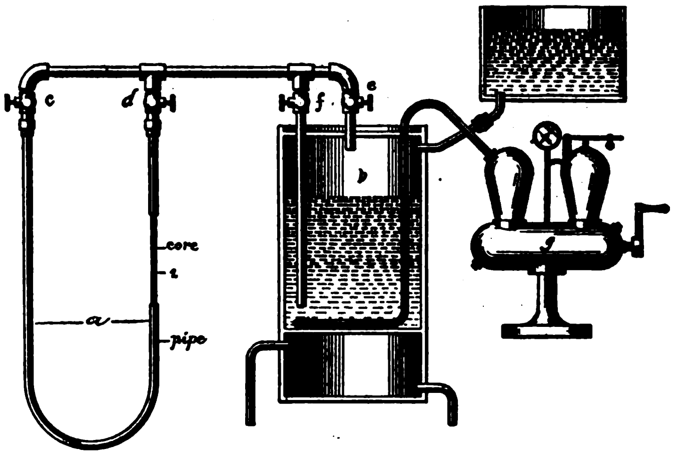
BY PROF. WM. A. ANTHONY.

In The Electrical Engineer for May 14, is a description of a rheostat constructed by Mr. Forée Bain, consisting of iron resistance wires immersed in a liquid. I constructed a rheostat of this description some twelve or fourteen years ago for use at the Cornell University for controlling currents used in electrical experiments. A rheostat constructed in this way, of course may be made of very much finer wire than one surrounded by air, but there is a difficulty met with when there is any considerable difference of potential between the different parts of the wire, and that is, the water is decomposed and the wire in that way corroded and finally destroyed by the action of the current. Finding that this was taking place, we used distilled water which worked better for a time, but even the distilled water, containing perhaps some traces of carbonic acid in solution, would, under strong currents, attack the wire, and this would of course increase its conducting power and the action would then go on more rapidly. We were obliged to give up this form of rheostat on account of the rapid destruction of the wire from this action. All this can, of course, be avoided by the use of some insulating liquid, as, for instance, some of the oils.

PATTERSON'S METHOD OF CABLE MANUFACTURE.

The extended use to which underground cables are being applied both for telegraph and telephone purposes in this country has tended to bring out prominently the effects of static capacity, and its retarding influence; and hence we find continual attempts being made to reduce this factor in cables, a seemingly small difference in this particular making, for instance, quite a large difference in the distinctness of telephonic transmission. Mr. W. R. Patterson of Chicago, who is well known in this department of work, describes in a recent patent a method of cable manufacture which embodies several novel features.

The method consists in placing the core of insulated conductors deprived of moisture within a pipe and then forcing insulating-filling into both ends of the pipe. Mr. Patterson considers a core consisting of insulated conductors thus deprived of moisture as an unsaturated core, as distinguished from such a core which has been dipped in some melted insulating substance—as, for example, hot paraffine—so as to saturate the fibrous insulating-covering of the wires. In connection with this process Mr. Patterson uses a generator of carbonic acid gas, and a charging-chamber containing the insulating filling. This apparatus is so constructed as to permit of forcing gas into the cable under a definite pressure and afterward forcing the insulating filling into the two ends of the pipe under a greater pressure, as would be necessary. The gas in the pipe will thus be compressed according to the distance to which the insulating filling is forced in.



Patterson's Method of Cable Manufacture.

The manner in which this is carried out in practice is shown in the accompanying diagrammatic view. The coil of pipe *a* is connected at each end with the reservoir *b* containing melted paraffine and gas under pressure. The cocks *c d* are both opened when the coil is being filled. First the gas-cock *e* is opened and the paraffine-cock *f* closed. The gas is then generated in the generator *g* at such pressure as is required. A pressure from seventy to eighty pounds to the square inch is found sufficient. The gas-cock *e* remaining open the coil of pipe *a* will be filled with gas and the air contained therein under the desired amount of compression. This is accomplished by shutting off the gas-cock *e* and opening the paraffine-cock *f*, and still further increasing the pressure—say up to ninety or one hundred pounds per square inch.

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[1] London *Electrician*.

In practice the ends are filled to a distance of about twenty-five feet each, regardless of the length of the cable. After sufficient paraffine has been forced into the pipe the cocks *c d* are closed and the paraffine is allowed to cool. The reservoir *h* is designed for supplying the tank with paraffine. The paraffine thus forced in at the ends acts as an effective means for imprisoning the gas, and at the same time acts as a dam to prevent the entrance of moisture into the cable.

CHAMBERLAIN'S COMPOSITE "WAVE" PINION FOR ELECTRIC CARS.

The high speed at which electric motors are required to operate in order to secure a proper efficiency has necessitated the employment of gearing to reduce the speed of the armature shaft to that of the car axles. The noise and vibration accompanying the employment of solid gear-wheels, however, soon became apparent, and means for overcoming both were applied, which consisted in the substitution of pinions built up of alternate layers or discs of steel and a variety of substances such as raw hide, fibre, etc. These composite pinions, it is true, largely reduced the troubles formerly experienced, but they introduced others which those operating electric railways have found to be of considerable moment. These consist principally in the fact that, owing to the layers of the composite pinion being placed in planes at right angles to the axis of the shaft, the wear on the all-metal gear-wheel is confined almost wholly to the parts opposite. The result of this is that circumferential grooves are worn in the all-metal gear, which leave ridges at the parts opposite the rawhide. The wear being thus confined to a portion only of the all-metal wheel, the same is more rapidly worn away and its working life is considerably shorter than would be the case were the wear equally distributed.

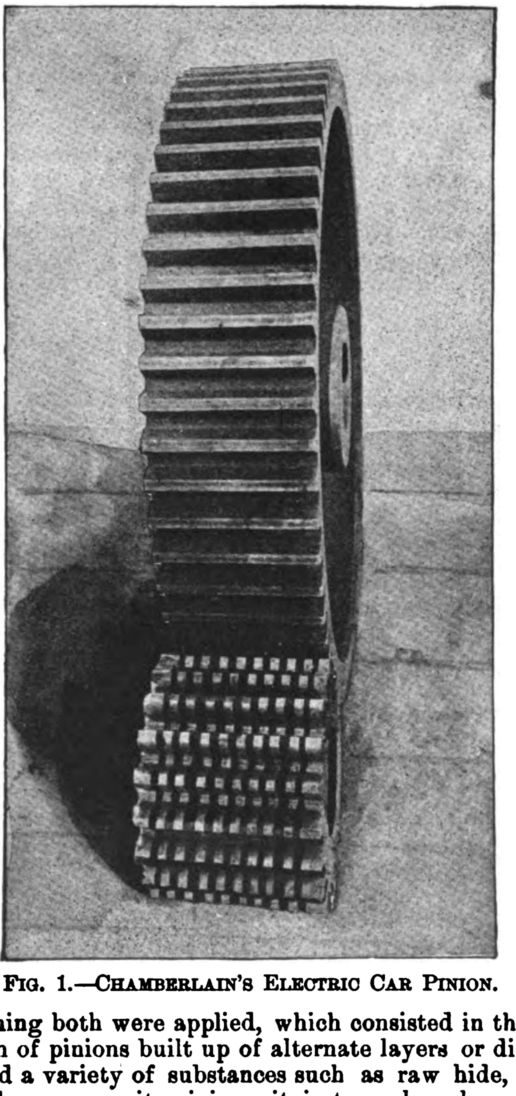


Fig. 1.—Chamberlain's Electric Car Pinion.

The exact nature of this unequal wear was well illustrated in our issue of April 23, in which was shown an engraving of a gear and pinion that had been in operation on a car which had travelled 18,000 miles.

While the non-resonant qualities of the composite gear were highly desirable, it was manifest that an improvement designed to afford an even wear of both pinion and gear was of not less importance, and this has been effected in a very simple and ingenious manner by Mr. Jacob C. Chamberlain of this city.

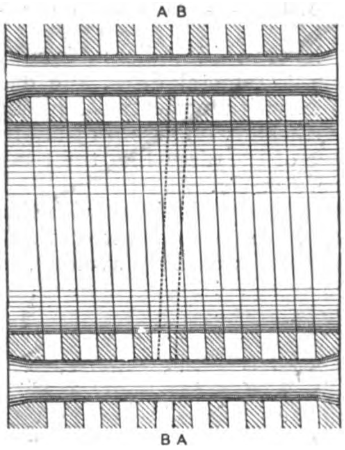


Fig. 2.—Chamberlain's Electric Car Pinion.

The desired object has been accomplished by placing the alternate layers of metal and rawhide of which the pinion is composed at a slight angle or cant to the axis of the wheel so that the metal portions in bearing on the all-metal wheel travel laterally upon the same in a worm-like or "wave" motion so as to distribute the wear.

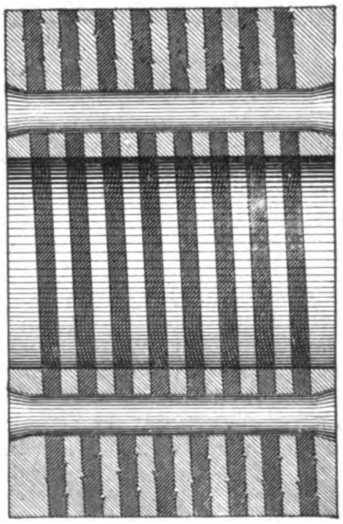


Fig. 3.—Chamberlain's Electric Car Pinion.

The pinion built up in this manner is shown in perspective in the accompanying engraving, Fig. 1, and its construction will be readily understood by an examination of the sectional drawing shown in Fig. 2. Here it will be noted the steel disc occupies the position A A at one point; during the next half-revolution, however, on account of its slant, it will have assumed the position shown in the dotted lines, B B. In other words, its periphery will have traversed a distance laterally somewhat greater than the width of the disc.

The result of this is that each tooth of a disc bears in part on a portion of the engaging wheel different from that engaged by the preceding tooth, thus shifting the wear and distributing it over the whole working face of the all-metal wheel.

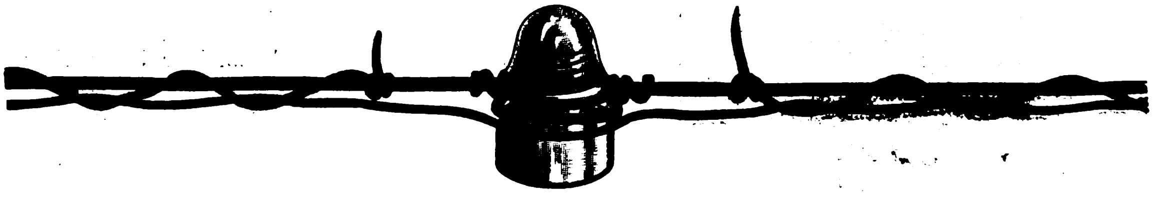
To fully accomplish this result, it is necessary to give a lateral displacement between opposite diameters of the discs equal to the thickness of the rawhide discs. It is also necessary that the number of teeth on the composite pinion should not be exactly divisible into the number of teeth on the all-metal wheel, and it is desirable that the numbers of teeth should be prime to, or incommensurable with one another, so that each tooth on the pinion shall be brought into engagement with each tooth on the gear-wheel.

To prevent the rawhide discs from slipping when clamped between the metal discs, the end faces of the latter are provided with projections, as shown in Fig. 3, which enter the rawhide. These projections are struck up out of the surface of the discs like the teeth of a file, and grip the rawhide securely.

Actual results already obtained with this new form of composite gear, have demonstrated that the difficulty formerly experienced is entirely avoided, so that another step has been effected in the economical operation of electrical railways.

THE SIMPLEX ANTI-INDUCTION WIRE.

Since the introduction of electric light and power circuits, and more especially since electric railways have become so common, the telephone and other delicate electric apparatus, have suffered considerably from induction troubles. Many attempts have been made to remedy this evil, and a variety of so-called anti or non-induction wires and cables have been invented with more or less satisfactory results. Recognizing the want for a thoroughly non-induction wire, the Simplex Electrical Company, of Boston, have recently brought out a wire which is specially designed for use on telephone lines, municipal signal systems, etc., and wherever a "silent" wire is required. To secure these results they have designed an arrangement by which there is secured, (1) a metallic circuit, (2) the parallelism of the conductors, and (3) placing them so that they may be close to each other and yet are kept absolutely apart, so that a short circuit is impossible.



Simplex Anti-Induction Telephone Wire.

These conditions are completely met in the wire shown in the accompanying engraving. The combination consists of a main copper conductor No. 16 B. & S. gauge, and a return wire of No. 10 galvanized iron, both wires being thoroughly insulated with the regular "Simplex" insulation. The two wires are kept close to each other, and yet always separate, by an ingenious weaving of cord formed of insulating material. As shown in the engraving, the line is entirely supported by the iron wire, thus attaining great tensile strength, and relieving the main conductor of all strain, one of the most important features being, that the main conductor is not tied anywhere, not even to the insulators. The separating cord is made of hemp, and is thoroughly saturated with insulating compound.

A telephone line composed of this wire, and about a mile long, has been in use for over a year in Boston, from the office of the Simplex Electrical Company. It runs on the same cross-arms with heavy power lines, and no inductive effects have ever been observed. At present there is a line 1¾ miles long in St. Louis, running from the office of the Municipal Electric Light and Power Company to their station, and they are so well satisfied with it that they propose to extend its use. In Pittsburgh, also, there is a telephone line 10¼ miles long, with twelve stations along the lines of the Federal Street and Pleasant Valley Electric Railway, the line being strung on the same iron posts with the railway feeders, without a particle of induction. The Simplex company put up these lines and guarantee absolute freedom from induction. The wire is made up complete at the factory and shipped in reels, with instructions for erection, which any lineman can understand

DR. DUNCAN'S ELECTRIC MOTOR.

Heretofore the employment of the two-pole dynamo and motor has necessitated a high rate of speed of the armature in order to obtain a proper efficiency with small weight, but it was soon recognized that a similar result could be obtained by the application of the multipolar principle, and indeed the drift at the present time seems to be largely in the direction of the construction of such machines. In carrying out the ideas on this line, Dr. Louis Duncan, of Johns Hopkins University, has designed a construction such that, with relatively small weight, high efficiency may be obtained and by which the revolving parts move at a low rate of speed. The machine is shown in perspective and partly in section in Figs. 1 and 2 and will be seen to consist of an armature, C, which is centered on the shaft, A, and which is under the inductive action of the magnets, B, the form of which is clearly shown in Fig. 4. These consist of a cylindrical portion which is shrunk on the shaft and have polar projections bent so that their inner surfaces form right angles enclosing the armature, and so arranged that the ends of the projections on the one side are midway between the projections on the other side. The engraving shows the armature having 28 polar projections, 14 on each side. The field windings, it will be noticed, are divided into two coils and are so connected as to magnetize the field magnets in the same direction. The essential feature is that the polar projections of one polarity on one side are opposite the spaces between those of opposite polarity on the other side and are fewer by some even number than the coils on the armature, the object of which will be described presently.

In the machine illustrated the field magnets revolve and are attached to the shaft, A, which it drives. The armature C is stationary, being held fast by the lugs shown. The armature is a ring similar in form to the well-known Pacinotti or Gramme ring, but differing essentially as to the method of winding. In a motor having 28 polar projections, as the one illustrated, it has 30 coils *d d′*, surrounding it, the adjacent coils being wound in opposite directions instead of all being in the same direction, as in a Gramme ring. This is shown in Fig. 3, there being a wire taken from the junction of the adjacent coils *d d′* to one bar of a 30-part commutator, as in the ordinary Gramme armature.

The commutator may be stationary, as shown in Fig. 1, or revolve, as shown in Fig. 5 at D′. In the former case the brush holder is revolved by a series of gear-wheels, so that the brushes make fourteen revolutions for every revolution of the magnets.

In the form of commutator shown in Fig. 5 the commutator has 420 segments, forming the commutator-bars, divided into 28 groups of 15 segments each. It will be observed that there are one-half as many segments on the commutator D′ as results from the multiplication of the number of polar projections by the number of coils on the armature. The turning of the commutator D′ coincides with that of the motor-shaft, A.

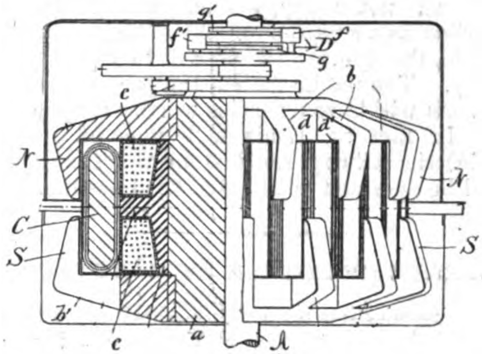


Fig. 1.—Duncan's Multipolar Motor.

The path of the current through the armature is shown by the arrows in Fig. 5. When the brushes are upon the segments shown, all the teeth of the armature are energized excepting those between the coils *d d′*, shown on both sides of the armature. These portions, by reason of the direction of the current and the windings of the coils, are consequent poles, and therefore not energized. The connections of the brushes are so arranged that when the current enters the coil *d d′* the teeth between those coils are exactly opposite the polar projections of the field-magnet.

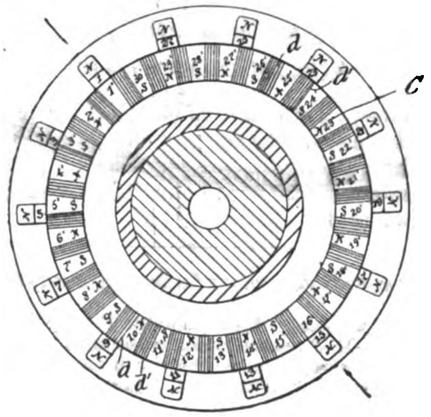
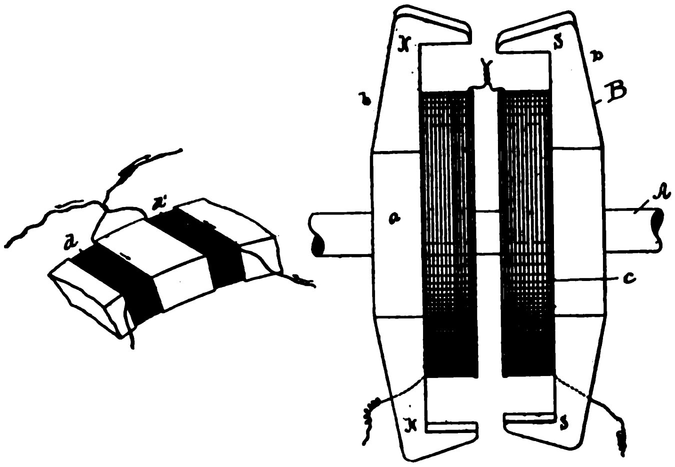


Fig. 2.—Duncan's Multipolar Motor.



Figs. 3 and 4.—Duncan's Multipolar Motor.

When the commutator has moved through one four-hundred-and-twentieth of a revolution, the teeth between the succeeding coils will be exactly opposite the succeeding polar projections. The same instant the brushes pass upon the succeeding segments of the commutator; these segments are divided into groups of fifteen each, and it is so provided that all the segments of each group send the current in the same direction, and also that each succeeding group of segments shall change the direction of the current. It is evident that there will be twenty-eight changes of the current at each revolution of the commutator—a number corresponding to the number of polar projections in the field magnet.

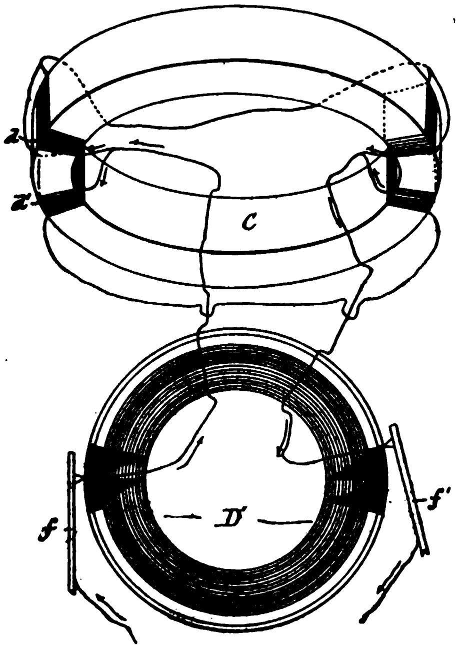


Fig. 5.—Duncan's Multipolar Motor.

The result of this arrangement is a steady continuous pull at the periphery of the armature which permits of obtaining a high effeciency at a comparatively slow speed.

THE MARX ACCUMULATOR.

The principle of an accumulator recently brought out by Herr Marx, of Berlin, is briefly as follows: If an electric current is passed through a dilute solution of hydrochloric acid and perchloride of iron, in which are immersed carbon electrodes, the following reaction takes place: $2\,FeCl_2 + 2\,HCl = Fe_2Cl_6 + H_2$. If, then, a carbon and an iron electrode are plunged into the electrolyte, the following reverse reaction, giving rise to a powerful current, takes place: $Fe_2Cl_6 + H_2O = 1\,FeCl_2 + 2\,HCl + O$. The perchloride may be prepared by taking 450 parts of protochloride of iron, 900 of water, and 500 of hydrochloric acid (25 per cent). The perchloride can then be concentrated, or even crystalized by evaporation, and in that state may be carried about. The carbon electrode in the second case must be very porous, or pierced with numerous holes. The iron electrodes are not consumed; on the contrary, on open circuit iron is deposited on them, so that they must be removed when the battery is not at work.

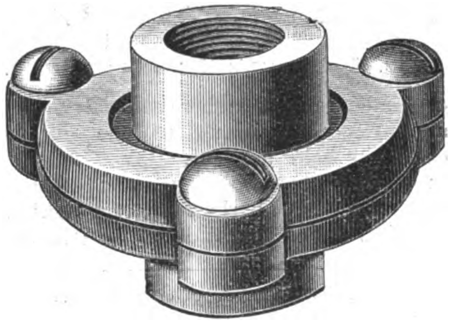
ALLOYS FOR STANDARD RESISTANCES.

At a recent meeting of the Berlin Physical Society, Dr. Feussner, in describing the methods employed at the Government Physico-Technical Institute for the measurement of electrical resistances, remarked that German silver wires had shown themselves unsuited for standard resistances, since their resistance increases regularly with lapse of time. On this account an alloy of copper and nickel was examined which is known commercially as "patent nickel." Wires made of this alloy possess a very low temperature-coefficient, and were found to be almost absolutely constant after being heated to 100° C. Several other alloys were also tried, as, for instance, various combinations of copper and manganese. Dr. Feussner stated that up to 30 per cent. of manganese—above which amount it was not possible to draw a wire in this alloy—they had yielded a negative temperature coefficient. When the alloy contained only a small percentage of manganese, the coefficient wasvery small, so that such wires would be suitable for the construction of standard coils.

GENNERT'S INSULATED JOINT FOR ELECTRIC LIGHT FIXTURES.

The success of incandescent lighting to-day, or, what amounts to the same thing, its rapid introduction into fine buildings and houses, depends greatly on the ingenuity brought to bear upon the details of the work. Anyone who will take the trouble to look through a collection of the devices of the past will be forcibly impressed with the crudeness that was permitted in some of the prime essentials of interior construction ; and he will see at once that the same careful study that brought the art of gas lighting up to its present point of perfection was necessary before the sanguine hopes of the electrical engineer could be even remotely realized.

Lamp sockets, keys, switches, ceiling blocks and cutouts, and many other details have thus been worked at and patiently brought up to the requisite standard of excellence ; and on this page we illustrate an improvement in insulated joints for electric lighting fixtures, especially of the class known as "combination fixtures." While to the uninitiated, the part in question may seem of small account, they who have been "through the mill" know how often and how seriously trouble has arisen just there. This improvement is the recently patented invention of Mr. E. F. Gennert, the superintendant of the E. P. Gleason Mfg. Co., of this city, whose object was to avoid the use of the ordinary unions, insulated screws, and other objectionable features, and to produce a joint of simple mechanical construction, easy of connection, capable of being kept tight, also having great strength, and an insulation which would render less possible the short-circuiting which is liable to occur by reason of the insulating material becoming coated with coal-tar, moisture, or other deposit from coal-gas when the joint is used on a combined gas and electric fixture. Most of our readers are doubtless familiar with the joint hitherto made by the company named, as it is in extensive use throughout the country. This new joint adds in various ways to the merits of the old joint, besides admitting of much cheaper production, so that it is intended to place it in direct competition with inferior joints whose sole virtue has lain in their dangerous and delusive cheapness. As will be noticed, there has been added a nipple of insulating material through which runs the bore or gas way. This nipple is of such a length that it leaves only the threaded ends of the joint uncovered. As these ends are engaged one by the service pipe and the other by the chandelier or fixture, it practically interposes a break of insulating material between the service pipe and the fixture, of such length that no deposit of carbon or other conductive matter from the gas can possibly carry a current across it. The conditions that are created favoring a short circuit by such gas deposits, are familiar to boards of underwriters, and others giving the matter their attention, and a hearty welcome awaits all such devices tending to establish for the incandescent light the truth and stability of its claims to safety and general superiority.



Gennert's Improved Insulating Joint.

AN ELECTRICAL SOLUTION OF THE DIFFICULTY.

Not long since there was trouble in St. Louis over the use of bobtail cars. The passengers would not deposit their fares in the box, but would pay the five cents only to a conductor. As the cars carried no conductors, the drivers had to collect the fares, and as may be imagined their life was not a happy one. Things began to look serious, when as a solution of the difficulty and an end to the trouble, the companies offered to equip their roads electrically. The public hailed the proposal with delight, and St. Louis will have a service worthy its population and wealth. In fact St. Louis will now have one of the largest electric railway services in the country, and the roads will be operated on the overhead system.

CHLORATE OF POTASH BY ELECTROLYSIS.

A manufactory has been established under the name of the Société l'Electro-Chimie, at Villers-sur-Hormes (Oise), for the electrolytic production of chlorate of potash by the patented process of Gall and Montlaur. A second and more important works is to be established in Switzerland, at Vallorbe. The raw material is chloride of potassium in aqueous solution. The electrodes are surrounded by diaphragms, of which the composition is kept secret. The current should measure five volts at the terminals of the bath, and it produces a decomposition of the chloride of potassium according to the formula

$$KCl+3H_2O=KClO_3+6H.$$

In practice several baths are mounted in series, and at the Villers-sur-Hormes works the current is 1,000 amperes at 25 volts. The output is at present 1 kilog. ($2\frac{1}{5}$ lb.) of chloride of potassium per 20 h. p. hour. This would correspond with $\frac{1}{2}$ cwt. of coal.

MAGNETIC SURVEY OF GREAT BRITAIN.

At a recent meeting of the London Physical Society, Prof. A. W. Rücker, F. R. S., communicated some of the results most recently obtained in the Magnetic Survey upon which he has been engaged in conjunction with Prof. Thorpe for some time past.

The Professor observed that in the account of their work already published they had pointed out that the tracts of country surveyed could be divided up into distinct districts ; and the distribution of the magnetic force in these districts had led them to form the provisional hypothesis that the variations were mainly due to the presence of large masses of magnetic rocks. If the hypothesis were correct it was to be expected that the vertical magnetic force would be a maximum over the central portions of such a mass, and that the horizontal forces would be deflected toward the centre. This had only been absolutely proved to be the case in two instances, though in other instances it appeared highly probable.

In order to investigate the matter further they selected two test districts for more minute examination last summer. The districts selected were the west coast of Scotland, and Lincolnshire and Yorkshire. These were selected because, in the first place, the local variations in these districts were very considerable, owing, probably, to the large masses of basalt present in them, and in the second place because they lay near the boundaries of the survey, so that any errors in the calculation of the normal force would be most likely to show themselves there. Magnetic maps of these districts, plotted from the obsrevations made last summer, were then exhibited.

The map of the Lincolnshire and Yorkshire district exhibited a magnetic ridge line, coinciding with the line of the Wealds, and along this ridge line the local variation in the vertical force was a maximum, while the horizontal forces were deflected towards it at points on either side of it. The map of the West Coast of Scotland showed that the distribution of the magnetic force was of the character which would be expected to follow from the presence of a large submerged mass of magnetic rocks off the south-west coast, due south of the Hebrides. The authors had calculated what the forces ought to be according to some observations made by Welsh in 1859 and 1860, and they found that they led to the same conclusions as their own.

In conclusion, Prof. Rücker stated that an application was being made to the Royal Society to assist in carrying out further observations.

THE BRUSH ARC LIGHT PLANT AT THE U. S. NAVY YARD, WASHINGTON, D. C.

BY GILBERT WILKES, ENSIGN U. S. N.

This plant, the pioneer shore electric installation for lighting purposes in the Navy, has just been completed, the contract having been awarded to the Brush Electric Company last fall. Not only has advantage been taken of the most approved practices at the time of commencing work, but several novel features have been introduced with good effect.

In order to avoid the expense of additional boilers, the dynamo house was built adjoining the main boiler house, which supplies steam for the machine shops surrounding it. The power plant comprises two Armington & Sims 10½ by 12 in. engines, each of which drives two Brush 30-light, 2,000 c. p., arc dynamos. The general arrangement of the station is shown in the engravings, Figs. 1, 2, and Fig. 3 shows a plan of the foundations.

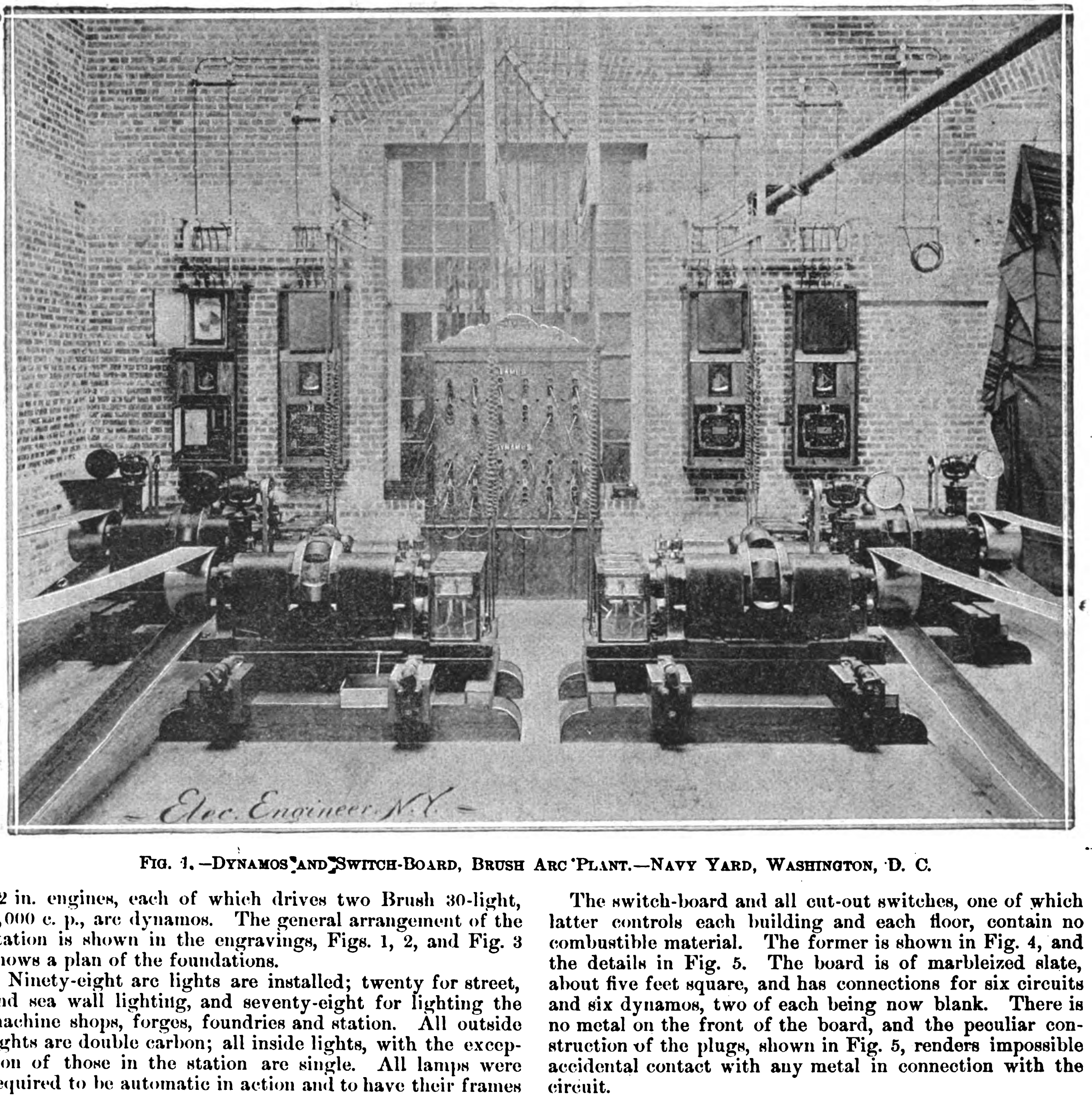


Fig. 1.—Dynamos and Switch-Board, Brush Arc Plant.—Navy Yard, Washington, D. C.

Ninety-eight arc lights are installed; twenty for street, and sea wall lighting, and seventy-eight for lighting the machine shops, forges, foundries and station. All outside lights are double carbon; all inside lights, with the exception of those in the station are single. All lamps were required to be automatic in action and to have their frames and casings insulated from the circuits.

The outside lines are run on dressed chestnut poles at a height of twenty-five feet from the ground. All of the wire used is that manufactured by the Bishop Gutta Percha Co., and was required to show an insulation of 1,000 megohms per nautical mile after an immersion of twenty-four hours. The lamp posts, which are of iron, have two insulating joints of hard rubber. All inside wiring is run on glass insulators, except in the dynamo room where porcelain knobs are used. Even here no concealed work has been allowed, and all wiring is in sight, being overhead.

Throughout all parts of the system every precaution has been taken to effectually guard against danger of shock and liability to fire. The dynamo frames are laid on an inch bed of sulphur, to prevent the absorption of moisture from damp contact with the foundations; the holding-down bolts are capped with wood, and the commutators and brushes are covered with glass cases, only the wooden handles of the rocker clamps extending through slots in the sides of the cases.

The switch-board and all cut-out switches, one of which latter controls each building and each floor, contain no combustible material. The former is shown in Fig. 4, and the details in Fig. 5. The board is of marbleized slate, about five feet square, and has connections for six circuits and six dynamos, two of each being now blank. There is no metal on the front of the board, and the peculiar construction of the plugs, shown in Fig. 5, renders impossible accidental contact with any metal in connection with the circuit.

Two long shops, containing heavy lathes and overhead traveling cranes, at first seemed to present a difficult field for lighting, but an excellent illumination has been obtained by suspending the lamps from iron outriggers, attached below the level of the cages, to the pillars supporting the crane tracks and about 18 feet from the floor. The lower halves of the glass lamp globes for inside use are ground in order to avoid shadows.

The following is a brief summary of the tests made upon the plant by the Government before acceptance.

Engines.—Two Armington & Sims, single, non-condensing engines, 10½x12 in.; 275 evolutions; variation in speed between no load and full load, two per cent.

Dynamos.—Four Brush 30-lighters, 2,000 c. p.

Heating.

Dynamo.	Length of run.	Load.	Heating above atmospheric temperature.	
			Armature coils.	Field coils.
B	7¼ hours.	25 lights.	48° F.	28° F.
C	7¼ "	25 "	56° F.	30° F.
E	6¼ "	29 "	54° F.	44° F.
F	6¼ "	19 "	44° F.	26° F.
E	2 hrs. additional	25 "	56° F.	46° F.
F	2 " "	25 "	46° F.	28° F.

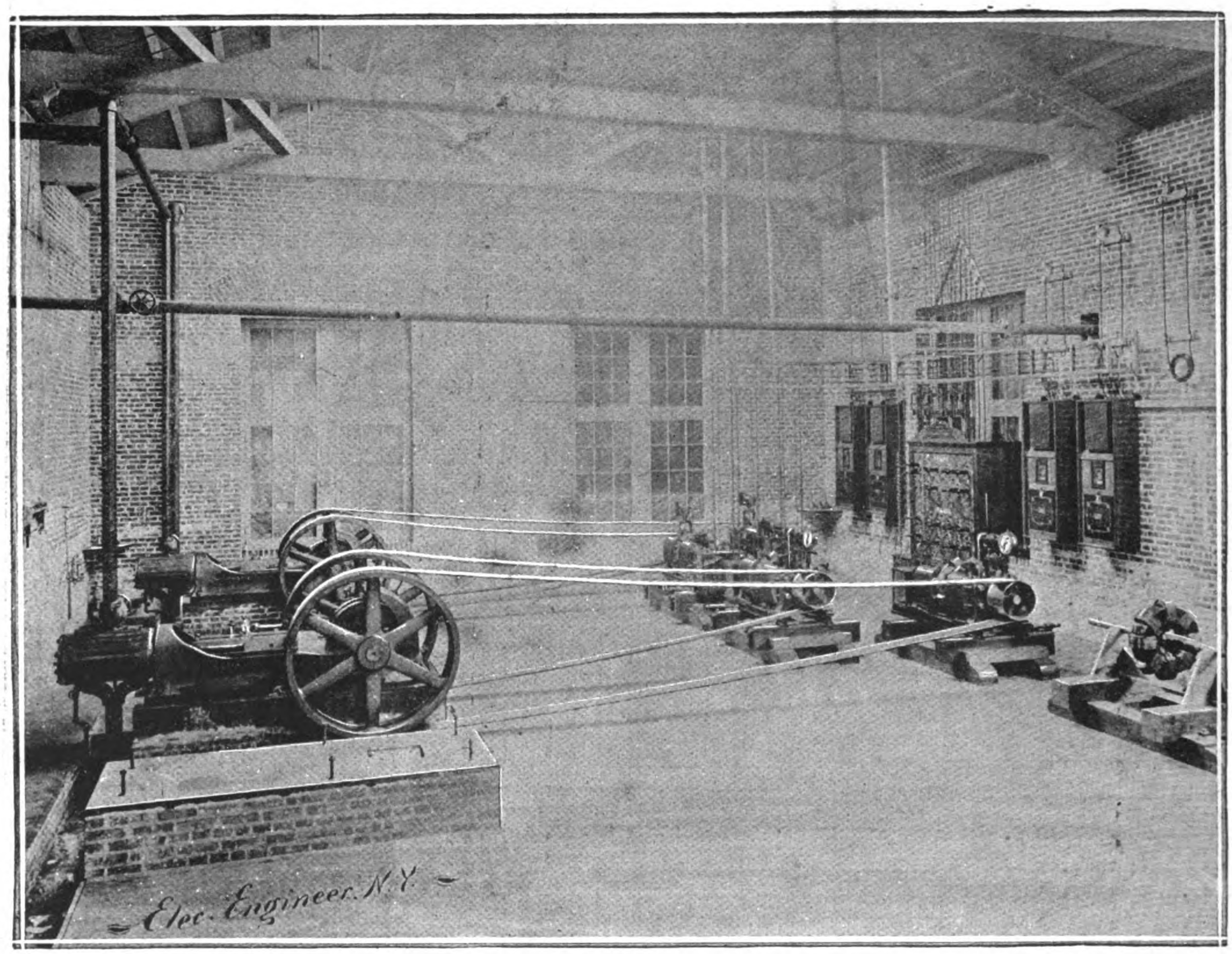


FIG. 2.—DYNAMO AND ENGINE ROOM, BRUSH PLANT.—NAVY YARD, WASHINGTON, D. C.

Efficiency.—Efficiency Test of E and F—driven from engine No. 2.

A Taber steam indicator was supplied by the Bureau of Steam Engineering, Navy Department.

The electrical instruments used were two Thomson astatic voltmeters and two Brush ammeters.

The voltmeters were adjusted previous to the test and the ammeters were standardized. Ammeter E was 2 per cent. high, ammeter F 2½ per cent high. Two readings of each instrument were taken to correspond with each card. The record is given below:

Efficiency Test.

Number of card.	m. e. p. per card.	End.	Constant for 275 rev.	Revolutions.	Amperes.		Volts.	
					E	F	E	F
1	32.5	Front	1.428	278	9.50	9.40	1290	1310
					9.45	9.35	1300	1310
2	32.5	"			9.50	9.35	1310	1320
					9.45	9.30	1310	1330
3	35.5	Back			9.55	9.30	1340	1320
					9.65	9.30	1400	1350
4	35.2	"			9.65	9.30	1410	1340
					9.65	9.30	1420	1340
5	13.2	"		284	Friction of engine only.			
6	13.0	"			"	"	"	"
7	1.93	Front			"	"	"	"
8	1.30	"			"	"	"	"

The speed was taken at each card and was steady.

The above figures give as the commercial efficiency of the Brush 30-light (2,000 c. p.) dynamo a fraction over 84 per cent.

Insulation.—The insulation of the lines was as follows:—

Number of circuit.	Class.	Number of cut outs.	Number of lamps.	Length of wire in feet.	Insulation.
1	Outside.	1	25	10,000	Over 10 megohms.
2	Shops.	1	25	5,000	"
3	"	5	29	5,000	"
4	"	2	19	5,000	"

When the tests were commenced, the insulation of the dynamo circuits from the earth was a few hundred thousand ohms, probably owing to the fact that the machines had been standing unused several weeks in the new damp building. After the runs necessary for testing—about 30 hours—the insulation rose to the following figures for the four dynamos—

B	750,000 ohms.
C	1 megohm.
E	900,000 ohms.
F	600,000 "

It will be seen by reference to the diagram, Fig. 3, that ample space is left in the dynamo room to provide for future enlargement of the plant.

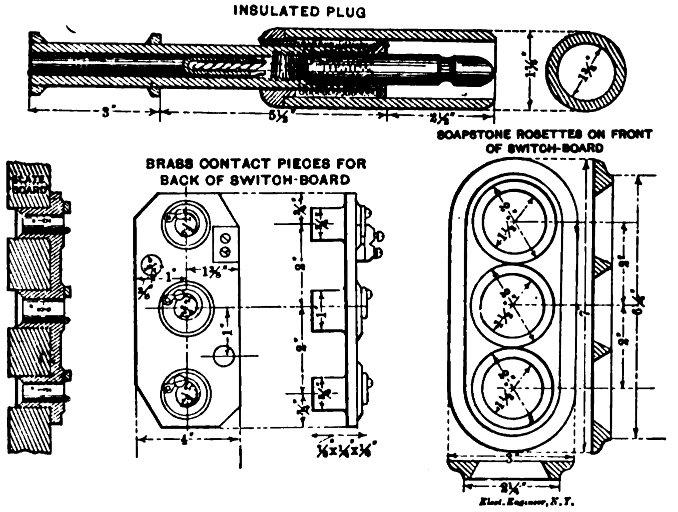

INSULATED PLUG
3"
5½"
2¼"
1⅜"
BRASS CONTACT PIECES FOR BACK OF SWITCH-BOARD
SOAPSTONE ROSETTES ON FRONT OF SWITCH-BOARD
SLATE BOARD
1⅜"
1"
2"
4"
⅛x⅛x⅛"
3"
2⅛"
Elect. Engineer, N.Y.

FIG. 5.

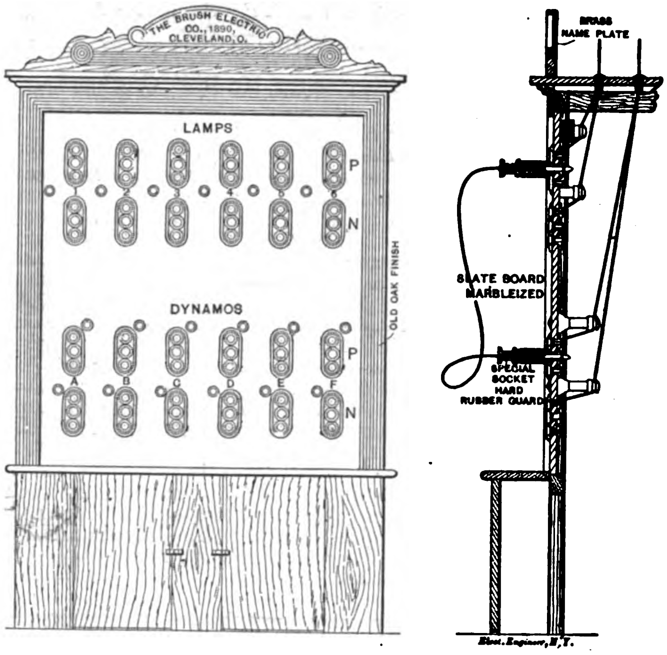


FIG. 4.

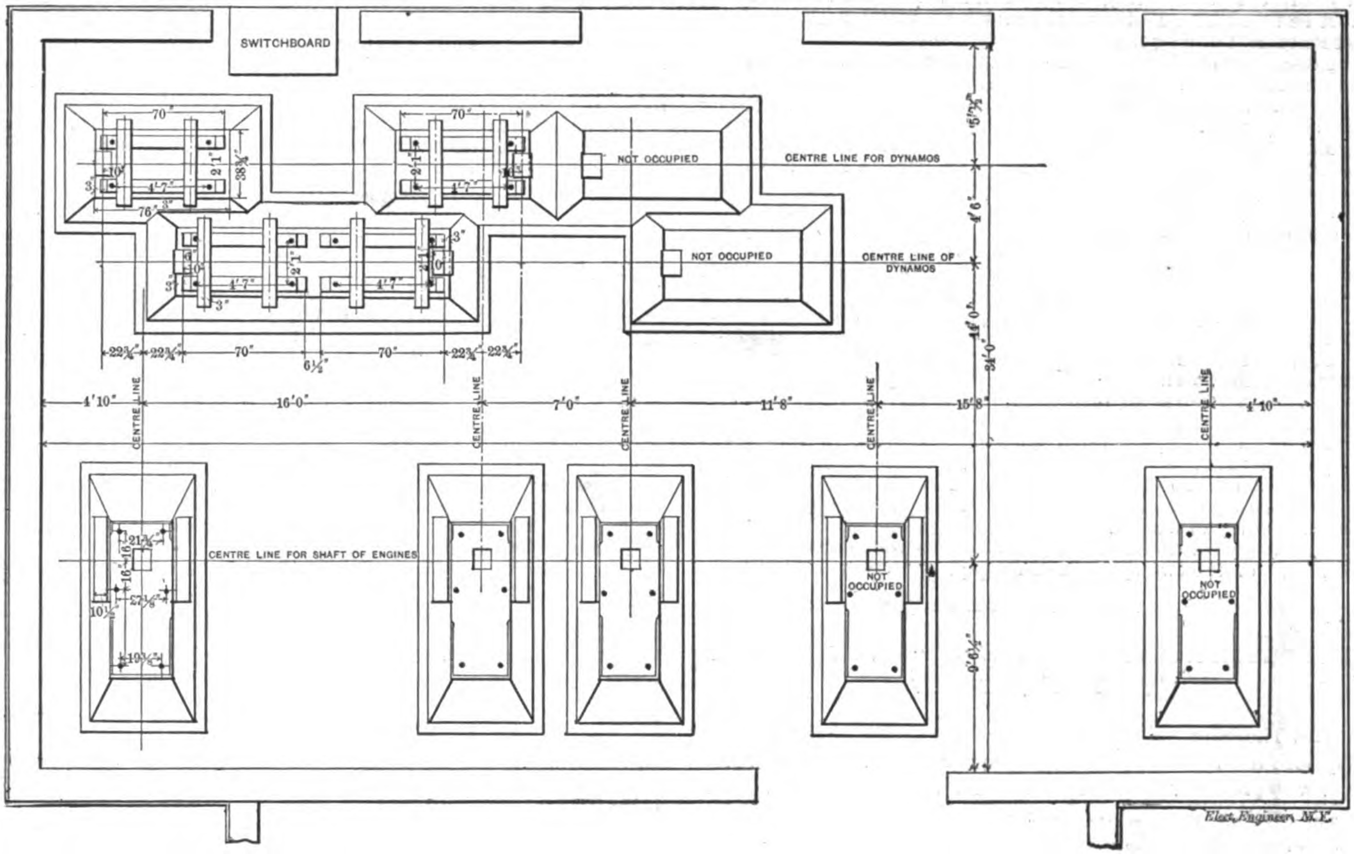


FIG. 3

FIGS. 3, 4 AND 5.—PLAN AND DETAILS OF THE BRUSH PLANT.—NAVY YARD, WASHINGTON, D. C.

WORDS OF GREETING.

THE ELECTRICAL ENGINEER appeared for the first time as a weekly journal on April 7th, having hitherto been published monthly for just ninety-nine numbers up to the date of the change. Mr. T. Commerford Martin and Mr. Joseph Wetzler, formerly of the *Electrical World*, are the editors under the new order of things, and we are sure these gentlemen enter upon their new undertaking with the best wishes of all who know them.—*Street Railway Journal, N. Y.*

MR. R. E. CROMPTON ON ALTERNATING AND DIRECT DISTRIBUTION.

WRITING to a friend in this country, Mr. R. E. Crompton says in a recent letter :—

With reference to the remaining part of your letter, I cannot help smiling at your using the expression that I have become a convert to the alternating system. I must say that I have not become so more than I used to be. It is very curious to me to see how completely I have been misunderstood both in this country and in America. I have always said that there is a proper sphere for the high pressure alternating system, using transformers and another sphere of operations for the low pressure continuous system.

The point in dispute has been where to draw the line between the two. I have never denied for a moment that for lighting scattered towns or suburban districts the alternating system is the most suitable, but I have denied that it is so for London or other large towns of the same nature. I notice that you American electrical engineers yourselves are beginning to appreciate the fact of the wide difference between the electric lighting hitherto carried out in America and the electric lighting as carried out in England. In most cases your lighting is for large buildings, such as hotels, large shops and public buildings, or offices and business premises, in fact, where the light is wanted for regular hours and where regular quantities of light are switched on.

In England, on the other hand, the bulk of the lighting is in private houses, each house having a very small number of lights in constant use, but, on account of our habit of entertaining at home, *i. e.*, giving balls and parties, each house is fitted with a large number of lights—in most cases ten-fold the number ordinarily in use. The result is to open tremendous difficulties in the way of the alternating transformer system, as each house must be fitted with enormous transformers, which are excessively uneconomical during the greater part of the year.

Hence, you will see that the present American demand is infinitely more in favor of transformers than it is here. I have also recently learnt the great difference between our lighting in London and yours in most of your great cities. Here the town is carefully districted out. We are compelled to lay conductors throughout the entire length of certain streets and to supply light to any householder who asks for it throughout the streets. Consequently, whether we wish it or not, a certain length and weight of conductor must be laid down sufficient to supply the entire number of houses fronting the streets. The cost of laying these conductors in London is almost independent of the weight of the copper in the conductors, as the cost is so largely made up of the cost of laying and making preparations for connection to houses.

On the other hand, in America, as far as I can understand, your companies as a rule extend their mains wherever they can get permission to do so in order to pick up customers, and as there is no dividing up of the city into districts each to be served by a supply company, in the sense that we have it in England, I fully agree that the alternating system, with its great flexibility, is well suited for so picking up custom in all parts of the town.

These two points, in which electrical supply in England and America differ so widely, are quite sufficient to account for the extraordinary misunderstanding and controversies in regard to the merits of the two systems of supply.

PROFESSOR ELIHU THOMSON ON "THE PROBLEMS OF THE FUTURE."

THE Thomson Scientific Club, of Lynn, Mass., celebrated on May 13th the first anniversary of its formation. Mr. S. E. Randall, who presided, introduced Professor Thomson, himself a past president, who spoke as follows :—

I am on the programme to speak on a subject which rather makes me a prophet; this subject is, "The Problems of the Future," and anything on this point necessarily reduces itself to a matter of opinion. We may predict and be mistaken. There are so many channels in which our sciences may develope that we cannot really say where they may run to. In electrical engineering, above all, we may expect the most stupendous advances. I need not say that this profession is the most modern of all, and a growing profession ; one which has attracted some of the greatest and brightest minds, and will continue to attract them. It has grown up in a very few years. I remember very distinctly, when I was a small boy, that all we knew was related to the telegraph and its working ; otherwise all was confined to some few experiments in the laboratory. We all know how this is now vastly changed ; there is scarcely a department of science which does not involve in it some electrical process, so greatly have the advantages of this branch been recognized. We find the process of evolution carried on and the laying aside and forgetting of other ideas. We can see that the foundation on which we have built is gradually becoming more and more firm, so that the engineering problems can be worked upon to-day, provided we have our facts properly organized. Some five or seven years ago it was more a matter of guess-work to determine the problems which presented themselves in electrical work, and those who could guess the best would show the best results. Faraday, for instance, was able to guess nearer the truth than another man would arrive at by a long course of mathematical working.

The future still looks bright; we need have no fear but that there will be just as much room for work as in the past, and a continually expanding field. We see a number of problems not yet resolved, but some have reached their final resolution. It is not a difficult undertaking to design dynamo-electric machinery of 300 to 500 h. p., which we regarded at one time as gigantic, when machines of 50 or 60 h. p. were considered as very large ones. The day is certainly coming when we shall find dynamo machines up to thousands of horse-power, where power is to be transmitted on a large scale or a great deal of lighting is to be done from a central station. The ideal system is one whose mains will supply all that is needed, whether in the way of light, power or heat, and all from the same mains without having a multiplicity of them.

It is much more easily told what will be the direction with regard to construction and arrangement of machinery than to foretell the discoveries which may be made to change the face of things. We hope the day will come when we shall be able to produce electricity from fuel direct; this is a great engineering problem, just how to do it; but there are not enough facts at hand at present to work upon. There is the thermo battery, consisting, as it does, of nothing more than a series of metals properly connected and heated at their junctions ; still, from this we obtain so little economy that the dynamo is very much ahead of it, though the present generating plant is cumbrous.

There are some obscure effects when heat is thus applied to metals, causing slight currents to travel through the circuit, but these effects are too small to be of any practical use ; the ideal arrangement being, as it were, a furnace which consumes the fuel and passes the energy along conductors to be used as required. If this came about, steam engineering would receive its death-blow. We can imagine a locomotive which obtains its current by combustion at places along the track, or even on the engine itself. This would enable us to do a great number of things which we now find expensive—it would light our buildings cheaper and decrease the cost of traveling. There is hope for such things, but I do not know if it will come in our days ; it is hardly possible for its growth to be too rapid, but a great deal of scientific work will have to be done first.

In the near future railways will be run by electricity ; not the small local roads, I mean, but the large ones connecting cities, and there is no reason why we should not expect higher speeds than we can attain at present with our steam locomotives. There we have reciprocating parts, parts which must be put into motion, stopped and reversed continually, while in the electric locomotive we have the simple rotary motion, which is all we need, and which makes it possible accordingly to run at a much higher rate of speed. Although the steam locomotive has been much improved, yet it can hardly compare with the economy of stationary engines placed where they can have an abundant water supply for condensation. We can, therefore, by employing stationary engines and electric roads do away with a great deal of unnecessary weight, and, the moving parts being symmetrical, we can attain a much higher speed—say 100 miles an hour. This would be a grand step forward which would save us a great deal of time. It might even be possible, making necessary arrangements to keep the train to the track, to reach a speed of 150 miles an hour. I really think that if we could come back after another hundred years, this would be the speed of traveling. It simply depends upon finding the necessary arrangement for applying sufficient power and the building of locomotives.

There is another field—the electro-chemical field. We know that electricity has been largely applied to the extracting of metals from the ores and their refining. As every chemical operation is nothing more or less than a changing about of affinities or likings for each other among the particles composing bodies, and, as electricity can govern these operations, it is evident that chemical operations can be conducted by electricity. There is room for investigation on this point, but it is a rare thing to find a man who is an accomplished chemist and at the same time a practical and thorough electrician. I might even go so far as to say that since all operations, such as the growth of plants, are known to be based upon chemical reactions, and many of them can be reproduced in the laboratory, so in the far future our food may be reproduced by electricity. We can make grape sugar, for instance, and it may be that we could, in a certain sense, become independent of farming. We may cause the combination of elements to take place which does take place in the growth of plants, so that we could take water-power and manufacture food.

These are only ideas thrown out which may be extended greatly, the getting of light without heat, for instance. That is undoubtedly one of the most engrossing engineering problems and one of the most desirable things we could wish to come about.

Our incandescent lamp produces a great deal of light, but there is some considerable heat too; we want to do without these low heat rays, and then we should obtain light at an exceedingly small cost.

These problems may be resolved in our time, but we have the satisfaction of knowing there is plenty of work to do in the future. (Cheers.)

TELEPHONE ENGINEERING.[1]

BY JOHN J. CARTY.

ELECTRICAL engineering is a young man's science. When Dr. Harvey announced his discovery of the circulation of the blood, there was not a physician over 40, who believed in the truth of his doctrine. The older men of the present day do not altogether reject electrical innovations and are in some cases even too credulous, yet the discoveries in science crowd upon each other so rapidly that only the minds of the younger men are sufficiently plastic to accept the changes which are constantly being made. While there is no science which stands in greater need of the calm and deliberate judgment which comes only with mature years, the extreme newness of electrical engineering places the young man and the old upon the same basis as regards experience, yet gives the former a tremendous advantage on account of the energy and enthusiasm of youth.

No disgruntled old fogy can tell us how he used to build telephone exchanges before we were born, nor that he operated a double trolley road in the "wet Fall of '38." On the other hand we cannot have the advice or experience of our elders in the technical troubles which daily beset us. A stranger going into the office of an electrical engineer with whom he is not personally acquainted is quite likely to make a mistake and select one of the clerks as the engineer.

Electrical engineering, although so new, has already divided itself into specialties and sub-specialties. None of its various branches offers a broader field or a more fascinating future than telephony. There has been a disposition to reserve the term "engineering" for the so-called heavy branches. There is nothing to support such a position, as although the telephonist is not called upon to deal with such works as a Brooklyn Bridge, or a St. Gotthard Tunnel, yet telephony is not so favored by gravity that its follower is not obliged to engage in some works which are heavy, and which require a high grade of mechanical skill.

A telephone office with 6,000 subscribers requires at least 20,000 wires; the 200 cables required to extend them from the switchboard to the basement of the building weigh 250 tons, and the task of so arranging them that any cable may be drawn out at will and be replaced by a new one is by no means simple; and where space is of such value as it is in this city, the question is further complicated by economical considerations affecting the room at our disposal.

The difficulties of underground construction can only be appreciated by actual contact with the subject; not only must the subways be kept ventilated and cool, as heat is an enemy of all insulation, but grave chemical and mechanical questions are encountered at every turn. The question of telephone cables alone is worthy of a life study by the most ambitious student.

A large switchboard, such as exists at Cortlandt street, New York, weighs 55 tons, and contains 1,980 miles of wire, all of which is laid out according to an elaborate and intricate system not equaled outside of the human body.

The analogy between the nervous system and the modern telephone exchange is striking and instructive, alike to physiologists and electricians. The general similarity between the telegraph cable and a bundle of nerves is well known and described in all works on anatomy. But there are certain special likenesses of structure which suggest similarity of action and which have never received the attention of physiologists on account of their not being familiar with telephony. For instance, in some of the highly specialized telephone systems, there are two wires extending to each subscriber; one by which messages are sent from the subscriber to the central and the other over which the central office sends communication to the subscriber. In the nervous system there is a perfect counterpart to this in the sensory and motor nerves. In case the finger is touched to a red hot iron, a message of pain is sent over the sensory nerve to the brain, which may be considered the central office of the body. Upon the receipt of this impulse at the brain a signal is transmitted along the motor nerve to the finger which is immediately withdrawn from the iron by the proper muscle. In the case of a learner at the piano, the movements of the fingers must be directed in detail from the brain, but after much practice this work is performed automatically by a ganglion, or knot of nerves, which may be considered as a branch office of the brain.

A parallel to this is found in a telephone system when subscribers at a distance from the exchange require constant communication with each other. The business is at first handled in the main office, but after its nature is discovered, a separate small office is established near the subscriber and the main office is relieved of this work.

If the line leading to a subscriber's station is cut off at a half-way point and a signal is sent to the central office, the operator there will naturally suppose that the call comes from the subscriber's station, although connection therewith has been entirely severed. Something like this happens when a man's arm has been cut off and the surgeon makes a bad job of it. The irritation of the ends of the nerves at the stump which formerly led to the fingers is supposed by the central office at the brain to come from the fingers and a sensation of pain at the fingers is produced, which is just as real as though they were attached to the body, instead of being buried in the family lot.

A section of one of the conductors sometimes used in the switchboard presents a remarkable resemblance to a section of a human nerve when viewed under the microscope, and the appliances used in telephone wires to prevent induction present an appearance strongly suggesting certain incisions and indentations in the envelopes of the nerves, the use of which has never been quite clear.

There is no doubt that impulses are transmitted along the nerves and it is no more than reasonable to suppose that, as in the case of telephone conductors, there should be devices employed to prevent lateral action between the nerves, both by conduction and induction. If such appliances do exist it would be of the greatest interest to the telephonist and to the physician to establish the fact, and from some investigations which I have seen conducted I think it may some time be done. I do not mean to imply that there is any identity between electricity and nervous force, or to give any aid or comfort to those charlatans who say that "electricity is life," or to the crank who talks of animal magnetism and has a headache unless he sleeps with his head to the north. I simply point out an analogy which may be helpful.

The electric light engineer can get along with the most superficial knowledge of the telephone, but the telephone engineer is obliged to follow closely the work of his colleague, the so-called "heavy engineer." The interferences produced in the telephone by railway and electric light circuit due to contact and proximity are of such a serious nature that in self-defense, if for no other reason, the telephone man is forced into the subject. The question of regulating electric light wires so as not to interfere with telephone lines requires a joint knowledge of both sides of the subject, and in endeavoring to protect his telephone line from contact with naked trolley wires, the telephone engineer is led quite as deeply into the question of fuses and other protecting devices as a man can well go. Aside from this, in many respects telephone practice is an exact counterpart of modern alternating current electric lighting, for in each transmitter is a converter presenting problems of design not inferior to those met with in electric light converters. Telephone repeating coils are simply converters which are expected to work at a high efficiency under variations of load, sometimes amounting to 1,000 per cent.; that is, they must be so constructed as to be operated by the most delicate voice currents and also respond to the comparatively heavy signaling currents from the alternate current generators which are employed. A modern telephone line containing 20 stations operated in multiple arc affords as beautiful an an example of the utilization of counter E. M. F. as can be found.

The telephone itself is an alternating current generator, whose output is so small that there are elements in line construction, to insure successful working, which have to be considered by the telephone engineer, but are ignored and in many cases almost forgotten by his electric lighting confrere.

Electro-static capacity is one of the most serious elements to be contended with in telephone construction. Were it not for this factor telephoning around the world could be accomplished with ease. The exact nature of this action in its bearing on telephony is not generally understood. The near proximity of telephone conductors brings out this effect very strongly, and although it can be somewhat reduced by a judicious selection of the dielectric, or medium separating the conductors, yet with our present knowledge there is no hope of getting a medium which shall permit less induction to take place through it, than air.

The problem then becomes a mechanical one and consists in keeping the conductors as far apart as possible. Of course, in underground cables this cannot be carried out to any extent, owing to the limited space at our command; but with aerial lines the case is different, and were it not for the limitations upon overhead construction imposed by the various municipal authorities a long distance telephone system between the most distant cities of the United States could soon be an accomplished fact. With overhead lines the question of space is not the only important one, but a high grade of mechanical and electrical engineering is required to construct a pole line. In a modern long-distance line the poles are set at exact distances apart and the tops kept as near the level as possible, and all strains are carefully distributed. It is due to these methods that during the great blizzard the long-distance wires furnished the only means of communication with the outside world although one message was sent from this city to Boston via London, by Atlantic cable.

After the pole line is erected the task of so arranging the wires that they shall not affect each other or be interfered with by any extraneous circuits is one for which we cannot turn to the text books for aid. The true theory of transpositions has never been published and I do not know half a dozen men who could design a transposition system for a twenty wire line from New York to Buffalo. The researches of Hertz, Lodge, and others have an important bearing on the inductive action between the telephone conductors, and as I have previously pointed out, they suggest a possible way out of the difficulties by some arrangement of dielectrics to control this action. The work of these experimenters should be closely followed by telephonists throughout the world.

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[1] A paper read before the New York Electrical Society, May 15, 1890.

Telephony is not wholly confined to the study of electricity; a broad and comprehensive knowledge of the subject requires also some familiarity with the physiology of the human voice and ear, and an intimate acquaintance with the science of acoustics. A telephonist should be a good deal of a physicist.

The phonograph is destined to form an important part of the telephone system of the future. At some time no doubt a phonograph may be inserted in a telephone line to act as a sort of "talk meter," recording all conversation which goes over it. I once thought of a curious use to which the phonograph might be put; that is, in transmitting speech through one of the existing ocean cables. I have no doubt that a cable could be designed which would enable us to talk direct to Europe. In such a cable the idea would be, to have the capacity and resistance as low as possible. Perhaps if there were a cable ten feet thick we might talk through it. With the present cables signals are transmitted so slowly that before one telephone vibration reaches its destination another is piled in on top of it and confusion is the result. Now, my idea was to first speak into a phonograph and then turn the cylinder at a speed no faster than the cable can take care of the impulses, and to have at the other end a phonograph also revolving slowly, (but not necessarily synchronously), upon which a record would be made. This second cylinder could then be revolved at the proper speed and if all went well the transmission of speech through an existing ocean cable would have been accomplished. It has been estimated from a microscopic examination of the word "Hello" on a phonograph cylinder that it contains sixteen thousand indentations. If this is true, it would be quicker to send the phonograph cylinder by mail than to rely upon the cable.

The radiophone of Prof. Bell involves the most delicate and complicated theories of interaction within human knowledge; by means of this wonderful instrument, as you all know, it is possible to telephone between distant points without the aid of a wire. The ether is used to convey the impulses. This instrument has not yet found its way into practical use, but must some day form an important part in telephone systems.

Telephone engineering is a science of the future. It is interesting on account of its possibilities rather than because of what has been accomplished. At the same time, the work which is daily being carried on by the system of the Long Distance Company shows that the plant of that company is unique among the engineering feats of the world.

Before the introduction of the telegraphs and railroads into this country it was doubtful if our union of states would be rendered sufficiently homogeneous to hold together; but steam and the telegraph have up to the present time enabled us to expand far beyond the conceptions of our fore-fathers and still remain the prosperous and united country that formed their ideal. Still, as our civilization becomes more complex, there is a demand for a more complete intimacy between the various portions of our body-politic, and the long distance telephone comes in to meet this want and supplement the railroad, telegraph and mail.

There is a possibility in connection with long distance telephone service which has never before been pointed out, and that is, its effect upon the language of our nation. As is well known, where people in different sections of a country rarely come in speaking contact with each other, there is a gradual change in the language which ultimately results in the formation of a dialect, and while the telephone can never compensate for those differences in speech which are due to climatic influences, it will be an important factor in preserving the uniformity of our language.

The telephone has never been used in a great war, but it is capable of martial application, perhaps not as important, but not less unique, than characterizes its use in time of peace. A short time ago, General Manager Hall, of the Buffalo Telephone Company, assembled in less than half an hour the entire Board of Trade of that city to attend a meeting on an important subject connected with their commercial interests, and which meeting could only have been called by the aid of the telephone. This should suggest to our military authorities its utility in the mobilization of the various state militia organizations. With a telephone in every block in every city in the land, it would be possible to assemble all of the state militia of this country in a few hours. In Germany, the telephone, like the telegraph and railroad, is controlled by the government, and telephone officials are assigned to a regular place in the field, to be taken on the commencement of hostilities.

Some time ago, Mr. Preece made some experiments to determine the effect of the great Deptford 10,000 volt alternating current dynamo upon neighboring telephones, and he came to the conclusion that when this dynamo was working all of the telephones in London would be interfered with, owing to their connection with the earth. At that time I pointed out that by means of a dynamo properly connected with the earth and a set of telephones a besieged garrison might communicate with a relief party by signaling through the earth itself. Similar signals might be sent with the aid of a telephone from a ship to the shore, or from one ship to another. In this connection a remarkable statement has recently been attributed to Mr. Preece to the effect that the operation of the Deptford dynamo created disturbance in the telephones of Paris.

It has not been my purpose in this paper to foster any antagonism between the different schools of electrical engineers, but rather to counteract a growing tendency on the part of young men in choosing a profession to consider the telephone question as solved, and not presenting a field in which their energies and abilities could find proper scope.

RESEARCHES ON THE ELECTRIC PROPERTIES OF RAREFIED AIR.[1]

QUITE recently Dr. Hertz has succeeded in obtaining an experimental realization of one of the ideas held in common by Prof. Poynting and Mr. Heaviside concerning electric oscillations, *vide* Wiedemann's *Annalen der Physik und Chemie*, T. xxxvii., page 395. It is believed that the electric oscillations in a wire take their origin at its surface; that they are extremely rapid, and that, while remaining practically superficial in character, they penetrate more or less into the interior. Dr. Hertz devised a sort of cylindrical cap which should serve to figure the conducting wire; 24 very fine wires were arranged between two metallic discs, the centres of which were connected by means of a sort of metallic axis which could have its metallic continuity interrupted by a spark micrometer placed on the axis. With this arrangement Dr. Hertz has succeeded in demonstrating that an electric oscillation does confine itself practically to the surface of a conductor, for it does not produce sparks in the micrometer that is placed on the axis which traverses the centre of this conductor.

These experimental results have induced M. J. Moser to direct his attention to the action of electric oscillation in rarefied air. In his investigations, the results of which were communicated to the Paris Academy of Science on February 24th,[2] 1890, he used rarefied spaces, without any metal or electrode of any kind, as conductors for the oscillations.

It has often been observed that tubes of rarefied air become luminous when they are in the immediate neighborhood of an induction coil that is being worked, but such tubes, according to all accounts, have been of the Geissler type, and have consequently been furnished with metallic electrodes which traversed the glass, or with electrodes which were simply applied to the exterior surface of the glass, like those of Gassiot. Moser's experiments, however, were carried out with tubes which were not then provided with metallic electrodes. The presence of the electrodes has hitherto always complicated the attempt to explain the phenomena which occur, and Moser believes that the elimination of these disturbing factors will tend to simplify the solution of many difficult problems in physics.

The arrangement devised and adopted by Moser was as follows:—A glass tube of air, 40 cm. long and 3 mm. in diameter, had its contents rarefied by means of a Geissler pump, after having been sealed off before the blow-pipe; this tube was then enclosed in another glass tube of 10 mm. diameter, and rather more than 40 cm. in length. The exterior tube was sealed up at one end, and at the other it was hermetically connected with a Geissler air pump. The rarefaction of the inner tube remains, of course, invariable, whilst that of the outer tube can be varied at pleasure.

When such an arrangement is brought into the neighborhood of an induction coil in action the inner tube becomes brilliantly luminous, showing a clear blue coloration without any lines of stratification if the outer tube has not yet been exhausted. When, however, the outer tube is exhausted, and its rarefaction varied, whilst that of the inner tube remains always constant, some remarkable phenomena are noticed, accompanied by unexpected variations in the color of the luminosity.

These seem to show, according to Moser, that three states of rarefaction are to be distinguished, these states of rarefaction being characterised by different electrical proportions. Thus air which conducts the induced charge when it is at a pressure of 1 mm. becomes insulating when the rarefaction is carried to the extreme limit—in fact there are three states of rarefaction which may be described as

I. Ordinary vacumm (insulating).
II. Vacuum 1 mm. pressure (conducting).
III. Extreme vacuum (insulating).

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[1] London *Electrical Review*.

[2] See THE ELECTRICAL ENGINEER, April 9.

It is a well-known fact that Geissler tubes, which are furnished with metallic electrodes, after having been subjected to extreme rarefaction, refuse to conduct the passage of the electric discharge, and this phenomenon has been the subject of much discussion. Some physicists have explained it by supposing the vacuum to possess insulating properties; whilst others, again, have attributed it to a property of the surface of the electrodes, assuming that they offer, under circumstances, great resistance to the passage of the discharge. In Moser's experiments there are no electrodes, so this latter theory breaks down, and the phenomena cannot be due to the resistance and passage at the surface of the electrode. It is indirectly connected in some way with the properties of the vacuum.

Since the results of these experiments were communicated M. Moser has been directing his attention to the study of the specific inductive power of spaces of rarefied air, and he gave an account of his more recent investigations to the Academy of Science at Paris about a fortnight ago.

The specific inductive power was measured in relation to the then states of rarefaction, which have been already alluded to. In studying the problem Moser made use of the following apparatus: —A large Leyden jar was constructed with a double bottom and double sides in such a way that it was possible to rarefy the air in the annular space between the double sides. The internal surfaces of the glass, which limited the air in the annnular space, was covered with layers of silver foil; these layers served as armatures; they were insulated, the one from the other, and communicated with the exterior by means of electrodes. The layer of air between these armatures formed, as it were, the dielectric.

A Geissler pump was connected with the Leyden jar in order to produce the necessary degrees of rarefaction, and these by means of a well-known device could be easily measured. The pump was also connected up with the system of concentric tubes which are described in the first part of the paper, and which was used to demonstrate the variation in the conducting power of varying degrees of rarefaction. An ordinary Geissler tube was also connected up, by exciting which it was possible to estimate the extent of the rarefaction when the manometer showed no appreciable alteration of level.

Moser then determined the conductivity and also the specific inductive power of this system of rarefied spaces, all disturbing influences being carefully allowed for or eliminated. The measurements were then made by well known methods, the only difficulty being the precaution necessary to be taken in order to avoid error. In these measurements a quadrant electrometer was used of the kind known as the Mascart-Carpentier, and with the induction coil and the constant battery a Sabine key was employed.

The jar was always charged for exactly the same time—namely, one minute—so that the results were strictly comparable.

For these states of rarefaction the following deviations were observed:—

I. 10 mm. of Hg.	II. 1 mm. of Hg.	III. Extreme vacuum.
318	318	318
318	320	320
318	320	320

These results conclusively demonstrate that there is practically no variation of the specific inductive power when the rarefaction is varied.

Spaces of rarefied air therefore exhibit two remarkable electric properties—namely, the variation of their conductivity, and at the same time the constancy of their inductive power.

WORDS OF GREETING.

THE somewhat irregular ranks of strictly electrical journalism have been very substantially reinforced by the appearance of THE ELECTRICAL ENGINEER as a weekly instead of a monthly, as heretofore, under the joint editorship of Messrs. T. C. Martin and Joseph Wetzler. These gentlemen have long been known to the electrical profession through their connection with the *Electrical World*, and it is not too much to say that they, by dint of perseverance and the high standard that they have set themselves in all their work, have made that journal what it is to-day, or rather what it was a few weeks ago. THE ELECTRICAL ENGINEER has always been the most scientific of the electrical journals, in fact it is just the paper that electricians take pleasure and profit in reading and preserving. The change from a monthly to a weekly has been welcomed and applauded by all its old readers and by many new ones, doubtless all the more so because that change has inaugurated the reign of Messrs. Martin and Wetzler in the editorial sanctum.—*India Rubber World.*

HIS CHECK NOT HANDED IN.

At the works of the Morgan Engineering Company, at Alliance, Ohio, we recently saw, says the *Iron Age*, an extremely simple arrangement which prevents all liability of accident by electric linemen repairing the conductors or lamps. On the wall facing the dynamo in the engine-room was a board about 6 inches high and 1 foot wide, provided with six hooks intended to receive six numbered checks. There were six men whose duty it was to look after any faults in the circuit and to make the necessary repairs. When any one of these men was called on duty he removed his check from his hook, carrying it with him. A glance at the board showed the engineer that one hook was absent, and that there was, therefore, one man engaged about the lines somewhere in the shop, and his instructions were imperative not to start the dynamo until the checks were in place on the hooks. When in place the engineer then understood that all those who were deputed to look after the lines and lamps were otherwise engaged, and that if any accident happened beyond that through tampering with the wires or through injudicious attempts to make repairs while the current was on he would be held blameless. The extreme simplicity of this method of preventing liability of accidents by the electric current will recommend itself.

ELECTRIC RAILROADING AT BIRMINGHAM, ALA.

NOTHING is more indicative of the rapid growth and development of the South than the manner in which the towns and cities in that part of the Union are adopting electricity for illuminating purposes as well as for operating all kinds of machinery. The street car service is also undergoing a revolution or transformation in that section at a rapid rate, and the time is not far distant when the southern mules—with all their mulish tricks and vices—will be relegated to other service than that of hauling street cars through the handsome cities and prosperous towns now springing up in every southern state.

Among the most prominent cities, which nature appears to have specially designed, by reason of its fine geographical position and almost illimitable mineral resources, to speedily become the metropolis of the Sunny South, is Birmingham, Ala., the citizens of which are as full of "sand" as the citizens of the great English town of Birmingham, the metropolis of the Midlands, after which it is named. The rate at which this southern city is growing is simply phenomenal; and within the last few days there has been commenced there an undertaking surpassing anything of the kind ever before attempted, placing Birmingham in the front rank of American cities. This is the consolidation of the Birmingham and Bessemer Railway Company, the Ensley Railway Company, the East Lake Railway Company, and the Union Railway Company, under the title of the Birmingham Railway and Electric Company. This corporation will now operate from sixty to one hundred miles of road. the entire length of which will be equipped with electricity, This equipment will necessitate an outlay of well nigh $2,000,000 and the contract for the entire undertaking has been placed with the Thomson-Houston Electric Company.

The consummation of this colossal undertaking is due to the enterprise and business capacity of Mr. T. T. Hillman, one of the most brainy, popular and successful men in the South, who, in this great undertaking has associated with him some of the strongest men of Birmingham. This gentleman owns rich coal and iron interests and may be considered one of the commercial leaders. Mr. Hillman has been elected president of the newly consolidated company and Mr. Robert Jeninson, manager. The company will at once place contracts for rails, car bodies, engines and boilers for the central power station which is to be equipped with a steam plant of 2500 h. p. capacity. The overhead construction will be adopted, the centre iron pole being used for supporting the conductors.

This consolidation and the placing of the contract with the Thomson-Houston Electric Company has created quite a breeze in many parts of the South, and it is a positive fact that already its effect is being felt among speculators and prospective settlers, the markets strengthening in every direction. The undertaking is considered by representative men to be fraught with good for the entire South.

THE TELEPHONE IN ENGLISH POLITICS.

THE *Freeman's Journal* of Dublin chuckles over a trick that was played upon the Conservatives on May 14, while a division was impending in the House of Commons on Mr. Russell's motion to adjourn the debate on the Irish agricultural laboror's bill. It appears that when the Conservative whips went to the telephones to summon a long list of members from the clubs for a hurried division, they found the instruments in possession of Parnellite members, who held conversations over the wires with fictitious friends, until the division bell rung, when, of course, it was too late for the wips to secure the aid of the missing members. The result was that the government was beaten of a "snatch' vote.

HON. A. G. BLAIR, attorney general of New Brunswick, president of the telephone company, together with the Hon. W. Pagsley, solicitor general, who is attorney for the St. John, N. B. Street Railway Company, has been in New York on a brief visit, inspecting electrical things, including the Electrical Exhibition at the Lenox Lyceum.

THE ELECTRICAL EXHIBITS AT THE PARIS EXPOSITION.[1]

BY CARL HERING.

PRIMARY BATTERIES.

GENERAL.

AMONG the very many exhibits in this class were a number of improvements and modifications which were of interest and showed some, though not very great, progress. The field being already so thoroughly studied, leaves little room for any very great progress; that shown was mainly in the form of slight, though not unimportant, improvements in the elements of the cells and in the details of construction.

The exhibits of powerful batteries showed that electric lighting from primary batteries is not only possible but also practicable, but even at its best it must still be considered a luxury on account of the expense, though if all of the facts and figures given by one of the exhibitors are correct, it has been reduced to the very low cost of $\frac{1}{10}$ cent per candle per hour, for labor and for material consumed; or $\frac{2}{10}$ cent per candle-hour, including everything. Although this is still between three and four times the cost of gas, yet it makes electric lighting by such means practicable for domestic purposes and for small power.

The very thorough researches of Renard are of some interest, resulting in his obtaining what is undoubtedly the lightest battery yet made. Most of the improvements in batteries were in the details of construction, the only one differing essentially from the old well-known types is the Lalande and Chaperon. In the Leclanché type the tendency appears to be to diminish their resistance, to cheapen the construction and to diminish the attendance required by them; in the latter direction the so-called dry cells are among the chief improvements. The Daniell cell was conspicuous by the absence of any improvements. With the exception of Callaud's well known improvement of employing gravity to separate the solutions, it appears to have originated as an almost perfect cell.

Processes of purifying zinc for the utilization of the residues of batteries, are also being developed. One of the interesting novelties was a battery in which the electricity is a by-product, the object sought for being the residue, namely, sulphate of copper.

Conspicuous by their absence were the inventors so often met, who claim to obtain more energy out of their batteries than is possible under theoretically perfect conditions. This alone is a proof of progress.

Exhibits by Countries.—The exhibits of primary batteries were almost exclusively in the French section, the only exception of note being one English exhibitor.

Classification.—Owing to the diversity of applications of the different cells, no classification will be attempted here, other than that those usually intended for great power will be described first, and those for small currents, last. Such a classification is, necessarily, only a very general one. Those of the first group are almost exclusively improvements and modifications of the bichromate of potash type of cell, and the latter of the Leclanché type.

BICHROMATE OF POTASH CELLS AND THEIR MODIFICATIONS.

The **GENDRON** cell, (French section, Bronze medal) is a zinc-carbon couple, with porous cup. The construction presents some points of interest, the object being to obtain great surface of electrodes, small distance between the plates, small quantities of liquid renewed continually and automatically and kept in continual circulation. The battery is intended to be used for lighting and for small powers.

Details.—The jar is a low, rectangular box made of sheet-iron, covered on the inside and outside with hard rubber which renders it perfectly acid-proof, while the box is light and strong. The porous jar is a narrow vessel with parallel sides, bent around parallel to itself, somewhat like a broad short letter S, the long parts of which (7 in number), are straight and parallel, forming practically several narrow porous cells communicating with one another so as to act as one, there being narrow parallel spaces between each two for a carbon plate. The porous cup has a hole at the bottom over a corresponding one in the jar, with a cock of special construction to drain off the liquid.

Each of the seven zinc plates is made of a number of rectangular pieces of thin sheet zinc, well amalgamated and afterwards secured together so as to form one thick plate amalgamated practically throughout its whole mass. The object of this is to secure good amalgamation and to be able to use the cheap impure zinc of commerce. These zinc plates are held in their porous cups at and by their edges by a three-sided, grooved frame, the open side being at the top. The zincs are thereby held like a slate in its frame and may readily be replaced. This frame is made of copper, well amalgamated, and the contact between it and the plate is made by means of the mercury. This simple mode of supporting the zinc plates has many evident advantages; besides being readily replacable, they are completely immersed and consumed, and the contact is always good and clean. The liquid is dilute sulphuric acid.

The carbon plates are placed between the parallel portions of the porous cup as well as on the inside of the four sides of the jar, being mitered, to hold them in place. The liquid is bichromate of soda.

Drain Pipe.—There is a drain pipe connected with each cell, the object of which is to draw off automatically the old liquid, at precisely the same rate at which the new liquid is being added, so as to keep the cell from overflowing or being drained. The liquid which has become passive is heavier than the fresh, active liquid and sinks to the bottom; the drain pipe must therefore lead it off at the bottom, while at the same time it must not allow the level of the liquid to change. To fulfill this condition it is made of two vertical concentric tubes having an annular space between them; the inside one is open at the top at the normal height of the liquid and leads out through the bottom of the cell and the outside one is open at the bottom and is higher than the normal level. The overflow therefore takes place from the bottom of the cell. There is one of these drains inside the porous cells and one outside. The supply of fresh liquid takes place in one corner of the cell and the drain is in the diagonally opposite corner, thus requiring the liquid to circulate continually through the winding parallel canals between the plates and the porous cup.

The liquids are supplied by lead tubes from two tanks above the battery. These tanks are filled by means of a very simple and ingenious, though not new, acid pump, consisting of a strong, flexible rubber tube laid in the form of a semi-circle and supported by a suitable guide; a wheel of slightly less diameter has rollers on its circumference, each of which in rolling over this tube compresses it and thereby pushes the liquid forward, similarly to the mechanical action of the intestines of the human body.

Size and Capacity.—A cell 18 inches square and 6 inches high, the active surface of the 7 zinc plates being about 5½ sq. feet, gives about 2 volts on open circuit and 100 amperes on short circuit, showing an apparent internal resistance (including polarization) of .02 ohm. The normal rate of discharge is 30 to 40 amperes.

Another exhibit of a complete primary battery for lighting purposes was that of the **AUTOMATIC ELECTRICAL CORPORATION**, limited, (English section, Bronze medal).

Details.—A comparatively small and compact primary battery is automatically and continually charging accumulators, from which the lights are supplied when required. The elements are amalgamated zinc in dilute sulphuric acid in a porous cup and carbon in a solution of bichromate of soda. The fresh liquids are supplied by canals, and the spent liquids are led off through holes in the bottom of the cells, closed by valves of special construction. The draining and refilling are operated electrically every 12 hours for the acid solution, and every three hours for the bichromate solution. A clock starts this operation. The jars are of hard rubber; the reservoirs are of sheet iron, lined with lead.

Output and Cost.—The battery exhibited is said to light 10 to 12 lamps of 10-candle power 6 hours per day, allowing 25 per cent. loss in the accumulators, and to cost $100. The zincs last about a week. The cost of running per 1,000 watts, (by which watt-hours are probably meant), taken from a report of a reliable authority, is about 50 cts., divided as follows: Bichromate, 20 cts.; sulphuric acid, 4 cts.; zinc, 12 cts.; mercury, 1.2 cts.; labor, 11.5 cts. At the rate of 2 watts per candle this corresponds to 500 candle-hours, or .1 ct. per candle per hour, which for a 10-candle lamp makes .1 ct. per hour. A company in London undertakes to install and run the battery, supplying everything, including the wiring for 10 lamps, charging at the rate of 1 penny (2 cts.) per hour per 10-candle lamp, which is certainly very cheap for incandescent lights from primary batteries. They use as a sort of meter the quantity of liquid used. In their factory they utilize the residues.

Another battery of some importance owing to the great power developed from small light cells, is that of Commander **RENARD**, (French section), and called the chlorochromic cell, or the tubular battery, on account of its appearance. It is at present used for small portable table lamps, the battery being in the base of the lamp, and it was suggested to be used to propel the great military balloon "La France." It is no doubt the lightest battery ever made.

General Description.—The cell may be said to belong to the bichromate class, in which the bichromate of potash is replaced by free chromic acid, and the sulphuric acid partially, or entirely, by hydrochloric acid. The cell consists of a long, narrow, cylindrical retaining cell of glass or ebonite; the negative electrode is a concentric tube usually made of a very thin sheet of platinized silver; it may also be of carbon; the positive electrode is a long, thin rod of zinc, concentric with this silver tube and insulated therefrom. The general arrangement of a battery with 12 cells, is shown in the accompanying illustration, Fig. 1.

Solution.—A very thorough scientific and practical research seems to have been made to find the best proportions for the battery solution, and to study its behavior. Of these results, we give here only the most important conclusions. They are doubtless quite reliable. By replacing the usual sulphuric acid, part for part, by hydrochloric acid it was found that the *rate of discharge* for the same cell was increased in proportion as the hydrochloric replaced the sulphuric, being increased five-fold when all the sulphuric acid was replaced, as compared with the usual bichromate solution, with sulphuric acid alone. The *capacity* of all these new liquids, however, remains about the same; that is, as the rate of discharge increases, the time of the discharge diminishes. The more hydrochloric acid there is, the more tendency there will be to disengage free chlorine gas; the liquid should, therefore, not have too much hydrochloric acid and should not be prepared too long in advance. The mixture most frequently used for lighting, in which the proportion of sulphuric to hydrochloric acid (see below) is 80 to 20, is quite stable and can be mixed two or three months in advance. When no sulphuric acid is used, the instability of the liquid is so great that it ought not to be used longer than two days after mixing.

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[1] Advance sheets of the report of the expert of the U. S. Commission to the Paris Exposition, Section "Electricity."

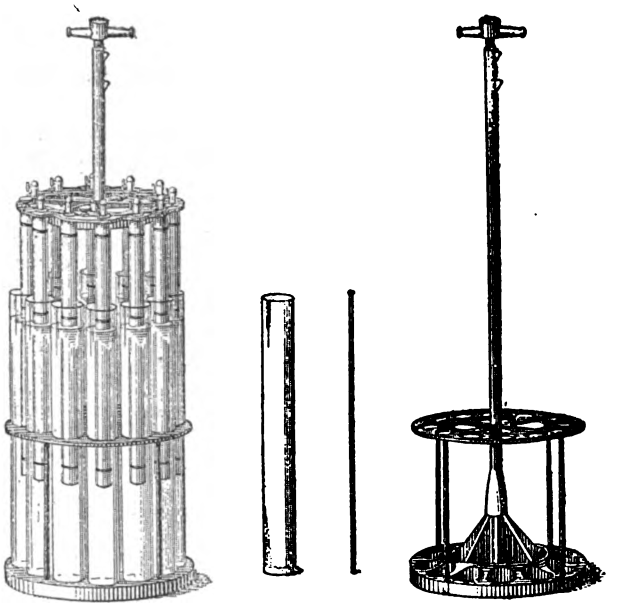


FIG. 1.—THE RENARD BATTERY.

The following three liquids composing the mixture, may be prepared in advance and kept in stock :—

Liquid A : Chromic acid, 530 grains ; water, 770 cub. cms.

Liquid BCl : Commercial hydrochloric acid of 18° Beaumé (or a sp. gr. of 1,143).

Liquid BS : Dilute sulphuric acid of 26° B. (or a sp. gr. of 1.25), consisting of 450 grammes acid of 66° B., and 800 cub. cms. of water.

The greater the proportion of the liquid BCl used, the more rapid will be the rate of discharge, and the shorter the time of discharge. The capacity is the same for all, being 50 to 60 watt hours per litre, the discharge being stopped when the difference of potential has fallen to 1.25 volt per cell. The following figures are deduced from a table given :—

Proportions by volume of the liquids A, BCl, and BS, respectively, 100, 20 and 80 ; specific gravity, 1.27 ; maximum current, 3.5 amperes ; coulombs, stopping the discharge when the current has fallen to half its maximum value, 10,630 ; watt hours, 3.54 and therefore the mean volts must have been 1.20, and the ampere hours, 2.95 ; watt hours per litre of liquid, 54.6 ; watt hours per kilogram of liquid, 43.0 ; weight of liquid per horse-power hour (metric), 17.2 kilograms, or 38.2 pounds. For the proportions 100, 100 and 0 (*i. e.*, without sulphuric acid), the figures are very nearly the same except that the maximum current is 8.5 amperes, the mean voltage remaining exactly the same.

The improvement, therefore, exists in two things, namely, in replacing the potash or soda salt by chromic acid and sulphuric by hydrochloric acid. One or the other of these changes alone will not have much effect, but it is with the two combined that the discharging rate is increased five-fold, and the total capacity increased 50 per cent.

Construction, negative electrode.—The negative electrode (positive pole), is made of a sheet of silver, covered with platinum ; it is 0.1 mm. or 0.004 inch thick, the platinum coating being only about 0.0025 mm., or 0.0001 inch thick. The platinum is necessary for protection, as the silver is attacked slowly when the platinum does not cover it. It is bent into the form of a long, narrow cylinder, the lap of which is left slightly open so as to allow the liquid on the outside to circulate and get into the interior to the zinc. The diameter of this tube should be about .4 to .6 of that of the retaining cell. The cost of such an electrode 1 inch in diameter and 9 inches long is $1.00. Three little hard rubber rings in the inside stiffen it and insulate it from the zinc rod which is passed through the holes in these rings. It may be replaced by a carbon cylinder, but is preferred as its conductivity is better and the weight and volume are less, the latter being practically nothing. It is very expensive, however, and should be replaced by carbon if the maximum output is not essential and the liquids not too concentrated.

Positive Electrode.—The zinc used is in the form of a thin zinc wire. It is made small in order to diminish the local action, (which is proportional to the surface) and so that it may be consumed completely by one charge of the liquid. The smaller the surface of the zinc, the more nearly is the consumption proportional to the current. Tests show that 1 litre of the liquid dissolves 85 grams of zinc. This would, however, require a zinc wire too small to be practicable, especially as the action is more rapid at the top than at the bottom, and would result in cutting it off at the top. It is therefore made slightly larger, in general .16 of the diameter of the cell, which is about ¼ inch for the normal cell. It is not amalgamated, and for several reasons. It was found that after a certain point of concentration was reached the amalgamated and unamalgamated zincs are attacked equally by local action. Furthermore, it increases the expense and makes such a thin rod as brittle as glass. Unamalgamated zinc also enables a leaden retaining tank to be used for table lamps, which would be destroyed by a single drop of mercury from the zincs.

Characteristics.—The characteristic of a cell is the curve obtained from the values of the difference of potential and the current corresponding to successive values of the external resistance varying from infinity or open circuit, to zero or short circuit. For a theoretically perfect cell, that is, without polarization as, for instance, in a Daniell cell, this ought to be a straight line, as in the accompanying diagram, Fig. 2, (excepting the curved part K A.) in which 1.67 would be the voltage on open circuit and 35.7 the amperes of current on closed circuit. The *constants* of such a cell would be the E. M. F. 1.67, and the internal resistance, which is evidently the quotient of 1.67 volts and 35.7 amperes, that is, 0.047 ohm. The curve shown is one actually obtained from one of these cells, without sulphuric acid. The points K and L are those between which the cell is used in practice, for which, therefore, the constants are those above given. For other cells, however, this characteristic is always a curve. By drawing a straight line through that portion of such a curve which represents the normal working conditions, and prolonging this line, the constants may be shown in the same way.

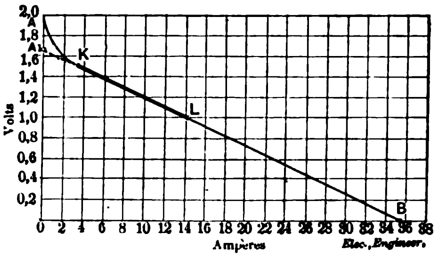


FIG. 2.

Output and Capacity.—The following are some of the dimensions and capacities of these cells. Diameter of cell, 1⅝ inches; tube of silver, about ¾ an inch; that of the zinc, about ¼ inch; height, not given, but probably 9 to 10 inches; difference of potential while working normally, 1.20 to 1.25 volt; internal resistance, 0.17 ohm; discharge stopped when the voltage had fallen to about 1.12. The solution was the one described above, 100, 20, and 80. 24 cells connected in series were discharged continuously through 3 lamps of 27 volts and 1.25 to 1.3 amperes each; the total quantity of liquid used was 6.3 litres. It ran 140 minutes, having given 347 watt-hours, making 55 watt-hours per litre of liquid, or 18 litres per kilowatt-hour. Constructed as light as practicable, it will weigh 40 kilogr. per kilowatt-hour, everything included, or almost 66 lbs. per useful horse-power per hour. For practical batteries of this class, it is doubtful whether this weight can ever be diminished materially.

The following are the dimensions and figures regarding the battery which is intended to propel the great military balloon "La France:" Cells, 4 cms. diameter; silver tube, 3.2 mm.; zinc, 6.4 mm. Total weight of a battery of 12 cells connected 6 in multiple arc, 10 kilogr. The useful power at the end of one half hour's running was 220 watts, thus requiring about 4 of these batteries per kilowatt ; or with a motor, about 4 batteries, weighing 40 kilogr. for a useful horse-power hour measured at the shaft. The weight that could be carried was 400 kilogr., therefore making 10-horse-power, or 7.5 kilowatts for 1 hour and 36 minutes. While these results are very good and far superior to others obtained, the inventor himself admits that we cannot hope that electrically driven balloons will ever be successful implements of war.

Table Lamps.—The following data is given by the maker of the table incandescent lamp furnished with a battery of these cells in its base. Weight, complete, 35 lbs.; height, clear, 33 in.; lamp, 25 candles; volts, 10 to 11; amperes, 4; mean duration, 5 hours,—maximum, 8 hours; price, $60; cost of recharge, 50 cts.; cost per candle-hour, 56 cts. The liquid is raised or lowered by air pressure produced by a small rubber bulb.

References.—For a more thorough description see the first volume of the *Bibliothèque de la Revue de l'Aeronautique*, a very complete abstract of which is published in *L'Electricien* of Paris, Nos. 363–4, March 29, 1890, *et seq.*, from which the above illustrations were taken.

EXPERIMENTS WITH A PENDULUM-ELECTROMETER, ILLUSTRATING MEASUREMENTS OF STATIC ELECTRICITY IN ABSOLUTE UNITS.[1]

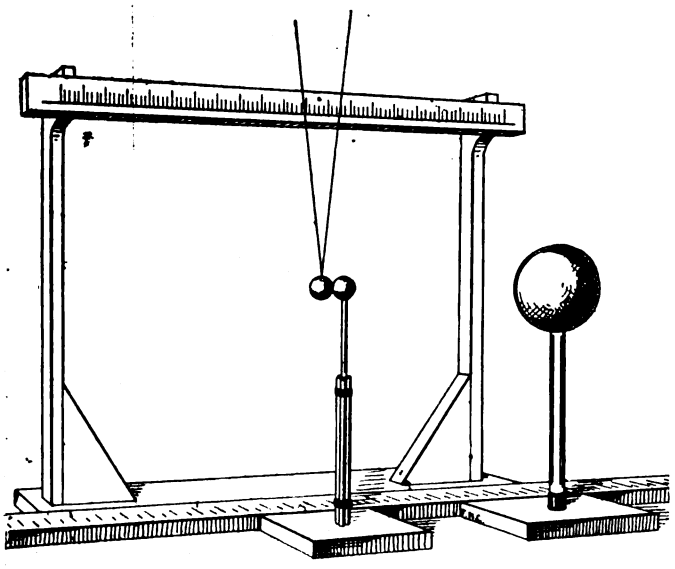
BY PROF. ALFRED M. MAYER.

Description of Apparatus.—A sphere, accurately turned out of velvet cork to 1 cm. radius, with a smooth surface, was heavily gilt. A staple made of fine wire was driven into this sphere, and a very fine filament prepared from a cocoon of the silk-worm was passed through the staple and the ends of the filament were attached, at a distance of 52 cms. apart, to a support near the ceiling. In this bifilar suspension the effect of torsion is eliminated, for the twist of one length of the thread is opposed to that of the other. The vertical length of the pendulum is 364 cms. or nearly 12 feet.

A scale of millimeters, pasted on a slip of glass is placed behind the suspending threads and 34 cms. above the center of the suspended sphere. A black band (not shown in figure) is painted along the lower edge of this scale, so that, when the line of sight is in the plane of the two threads of bifilar suspension, we see a fine white line on this black ground. This permits fine readings of deflections along the scale of millimeters.

The force pushing the pendulum from the vertical will be as the weight of the sphere and ½ the weight of suspending thread into the sine of the angle of deflection. The weight of sphere and one half of thread is 990 mgrms., and the force of *one dyne* will give to the pendulum a deflection from the vertical of 3.4 mm. on the scale above the sphere, if we take g=980.2 cms. at Hoboken.

As not over 2° of deflection was used in the experiments, it follows that the difference between the sine of the deflection and its chord is just measurable, amounting to only ⅙ mm. fo an angle of deflection of 2°. The scale was inclined to the horizontal so as to coincide with the chord of 2°.



PENDULUM ELECTROMETER APPARATUS.

Another sphere of brass of one cm. radius was supported on a rod of glass; the latter coated, while hot, with a film of paraffine. This rod was mounted vertically on a wooden base which slid along a scale of millimeters on a table. This scale and the one before which the pendulum is deflected are so placed that when the suspended cork-sphere and the sphere on the rod are just in contact the threads of suspended sphere read 0 on the upper scale, while the vertical plane through the center of the sliding sphere reads 2 cm. on the lower scale, this being the distance apart of the centers of the spheres.

The ends of the thread, to which the gilded cork-ball is suspended, are passed through small staples in a board fastened to, or near, the ceiling, and are then joined together and passed around a spool fixed by a screw midway between the staples. By turning the spool the thread is wound on or off it, and thus the height of the pendulum is adjusted so that its center and that of the sphere on the glass rod are in the same horizontal line. When this adjustment has been made the head of the screw is tightened on the spool.

The sphere on the rod is charged and then slid along the scale on the table till it is in contact with the sphere of the pendulum. The charge is thus equally distributed between the spheres; and when the sphere on the rod has been brought to 2 cm. reading on its scale, the deflection on the upper scale plus 2 cm. gives the distance of centres of spheres apart, and the force (f) in dynes in the rate of 3·4 mm. to the dyne and $f=\frac{qq'}{D^2}$; and since $qq'=q^2$, $q=D\sqrt{f}$, as the sphere, being of 1 cm. radius, has unit capacity.

Influence of the surface of the room and of surrounding objects on the capacity of the sphere.

If we assume (to be within bounds) that the above influences are equivalent to a sphere of 100 cms. radius, concentric with the suspended sphere, we have $C=\frac{rr'}{r'-r}=\frac{100}{99}=1.01$. This gives for the effect of the induction of the room in increasing the capacity of the sphere, the same as would be produced by increasing the radius of the sphere by $\frac{1}{10}$ mm.; a quantity too small to be taken into account in experiments with this apparatus, as it is not possible to form the sphere to this degree of precision. We would here remark that this apparatus is not an instrument of extreme precision, though it will measure to $\frac{1}{30}$ of a dyne, and with a sphere of pith, which has ⅙ of the specific gravity of cork, it may measure to the $\frac{1}{60}$ of a dyne, if the apparatus is guarded from air currents; but this instrument gives the means of readily making electrostatic measurements before a class, and of presenting clear conceptions of the nature of these measurements.

Experiments to determine if apparatus gives the law, $f=\frac{qq'}{D^2}$.

Eight experiments are given in the following table. The first column gives the number of experiment; the second, the deflections in centimeters of the pendulum; the third, the corresponding distances of the centres of the two spheres; the fourth, the direct ratios of the deflections; the fifth, the inverse ratios of the squares of the distances between centres of spheres; the sixth, the approximations to the law of the inverse squares. By approximation we mean $\frac{d}{d'}\div\left(\frac{d}{d'}-\frac{D'^2}{D^2}\right)$.

Exp. 1	d=5·25 d'=1·15	D= 5·25 D'=11·15	$\frac{d}{d'}$=4·56	$\frac{D'^2}{D^2}$=4·51	Approx. $\frac{1}{91}$
" 2	d=5·0 d'=2·4	D= 5·0 D'= 7·2	" 2·08	" 2·07	" $\frac{1}{208}$
" 3	d=4·8 d'=2·3	D= 4·8 D'= 7·0	" 2·08	' 2·12	" $\frac{1}{52}$
" 4	d=3·5 d'=2·1	D= 5·5 D'= 7·1	" 1·66	1·66	" $\frac{1}{\infty}$
" 5	d=2·65 d'=0·87	D= 5·65 D'= 9·87	" 3·046	" 3·051	" $\frac{1}{609}$
" 6	d=2·75 d'=1·5	D= 4·77 D'= 6·5	" 1·83	" 1·85	" $\frac{1}{91}$
" 7	d=3·02 d'=2·87	D= 4·86 D'= 5.02	" 1·052	" 1.066	" $\frac{1}{76}$
" 8	d=3·10 d'=2·94	D= 4·94 D'= 5.10	" 1·054	" 1.065	" $\frac{1}{96}$

The average approximation is quite close to the law, being $\frac{1}{108}$.

One cause of this departure from the law of the inverse squares is the mutual influence of the spheres causing a departure from uniform electrical density over their surfaces.[2] If we replace the cork ball by one of pith, the approximation to the law is much closer, as the distances of the spheres in the experiments are much greater. A gilded pith ball of 1 cm. radius, made of pieces of pith cemented together, weighs, with one-half of the suspending filaments, only ·25 grm., about ¼ of the weight of the cork ball[3] and filament; so that, on the pith ball pendulum, a dyne will produce a deflection of 13·3 mms. This pendulum is not suited to class experiments, as it is too readily moved by air currents, and has to be inclosed in a large cage formed of silk fastened to a light wooden frame. When this pith sphere is thus protected and suspended by an exceedingly fine fibre, it gives as close an approximation to the law of inverse squares as does the Coulomb torsion-balance. Another cause of error is the continual loss of electricity during the experiments. This error can be partly corrected by repeating as nearly as possible the first experiment and properly combining this third experiment with the first. This was not done in those given, our object having been to see how close an approximation to the law is reached by methods suited to experiments before a class. The error caused by loss of electricity can be allowed for in measurements of quantity and potential by a determination of this loss by experiments similar to those given below.

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[1] *The American Journal of Science.*

[2] On this subject see Sir W. Thomson's Papers on Electr. and Mag., p. 86; and Mascart and Joubert's Electr. and Mag., vol. i, p. 153, and vol. ii, p. 173.

[3] The specific gravity of elder pith, in air, is .04. This I determined by weighing a right parallelopiped cut out of this substance. The specific gravity of cork is .24.

Experiments to determine the law of the loss of electricity, per minute, from a sphere of the radius of (1 cm.) *the unit of capacity.*

The pendulum sphere was touched by the charged sphere on the rod, and the latter remained in one position during the experiments. The deflections of the pendulum and the distances of the centres of the spheres were read every three minutes.

At the heads of the columns following table d stands for the deflections in cms.; D, for the distances apart of the centers of spheres in cms.; f, for force in dynes; q, for units of quantity of electricity.

Times.	d	D	$f = \frac{d}{.34}$	$\sqrt{f}$	$q = D\sqrt{f}$
0m.	3.10	5.10	9.1176	3.02	15.4020
3	3.02	5.02	8.8823	2.98	15.9596
6	2.94	4.94	8.6470	2.94	14.5236
9	2.865	4.865	8.4264	2.90	14.1085
12	2.797	4.797	8.2264	2.87	13.7674
15	2.73	4.73	8.0294	2.83	13.3859
18	2.67	4.67	7.8529	2.80	13.0760
21	2.60	4.60	7.6443	2.76	12.6960

Times.	q	Dif. 0 and 3; 3 and 6, etc.	Mean q	Loss per 3 m.	Loss per m.
0m.	15.4020				
		.4424	15.1808	$\frac{1}{34}$	$\frac{1}{103}$
3	14.9596				
		.4360	14.7416	$\frac{1}{34}$	$\frac{1}{103}$
6	14.5230				
		.4151	14.3160	$\frac{1}{34}$	$\frac{1}{103}$
9	14.1085				
		.3411	13.9370	$\frac{1}{41}$	$\frac{1}{123}$
12	13.7674				
		.3815	13.5766	$\frac{1}{35}$	$\frac{1}{105}$
15	13.3859				
		.3099	13.2309	$\frac{1}{42}$	$\frac{1}{126}$
18	13.0760				
		.3800	12.8860	$\frac{1}{34}$	$\frac{1}{103}$
21	12.6960				

The mean loss per minute is $\frac{1}{103}$ of the charge; and the difference between the maximum and minimum measured is $\frac{1}{565}$. In Coulomb's experiments (Mem. 3d 1785) this difference amounts to $\frac{1}{339}$.

The loss of electricity, as is well known, follows Newton's law of cooling; and these experiments show the operation of this law very closely.

The coefficient thus found is, however, only applicable to experiments made in similar hygrometric and barometric conditions of the air, for the coefficient varies with these conditions.

In the above experiments the barometer was at 30.069 ins.; the force of vapor .251 ins.; and the relative humidity 31.8. Temperature of air, 73° F.

Experiments on the distribution of electricity on a cylinder, like the one experimented on by Coulomb.

In his sixth paper, of 1788,[4] Coulomb gives his measurements on the distribution of electricity on a cylinder with hemispheric ends. In was 30 French inches long and 2 French inches in diameter. I made a similar cylinder of wood neatly covered with thick tin-foil. With it I made the following experiments to test the value of the pendulum-electrometer from measurements that could be compared directly with those made by Coulomb with his torsion-balance.

To do this I had first to determine the fraction of the charge lost by this cylinder per minute. This I did by transferring, at intervals of three minutes, a proof-plane from the charged cylinder to the stationary sphere of the pendulum-electrometer, and made a series of experiments similar to those given under "Experiments to determine the law of the loss of electricity, etc." It was found that the charged cylinder lost .04 of its charge in one minute.

The following experiment, No. 9 of the series given, will show the manner of procedure in making a measure of electric density at a point on the cylinder.

Proof-plane carried from contact with middle of cylinder to stationary sphere of pendulum-electrometer gave a deflection of the pendulum of 3.55 cms., with distance of centers of spheres of 5.56 cms. $\sqrt{3.55} \times 5.56 = 10.43 =$ charge on middle of cylinder. After an interval of two minutes the following measure was obtained from charge of proof-plane conveyed to electrical-pendulum from contact with the end of the cylinder:

Deflection of pendulum = 6.7 cms.

Distance of centers of spheres = 8.7 cms.

$$\sqrt{6.7} \times 8.7 = 22.53,\ 22.53 + (22.53 \times .08) = 24.33,$$

$$\text{and } \frac{10.43}{24.33} = 1 : 2.33.$$

That is, the ratio between the electric density on the middle of the cylinder to that on the end is as 1 to 2.33.

The following measures were made in the above manner:

	Density on Middle.	Density on End.		Density on Middle.	Density on End.
1	1.00	2.42	7	1.00	2.21
2	"	2.36	8	"	2.31
3	"	2.20	9	"	2.33
4	"	2.22	10	"	2.23
5	"	2.26	11	"	2.26
6	"	2.20	12	"	2.21
	Mean = 1		:		2.27

Coulomb gives for the distribution on this cylinder the following ratios:

At middle of cylinder.......... .... 1.00
" 2 ins. from end.................. 1.25
" 1 in. " " 1.8
" end............................ 2.3

The mean of our measurements gives for the ratio of densities at middle and at end of cylinder, 1 : 2.27, which is substantially the same as Coulomb's ratio of 1 : 2.3.

Measurements of Quantity and Potential.

The quantity and potential of the charge on a sphere of known radius are readily measured by the pendulum-electrometer, as shown by the following experiments:

The charged sphere, of 1 cm. radius, was brought in contact with the electric pendulum, and the force in dynes exerted on the latter was 7.058. The distance apart of centres of spheres was 7.4 cms. This gives for the quantity (Q) on the pendulum, $Q = \sqrt{7.058} \times 7.4 = 19.7$ units of electricity.

As soon as the readings of the deflection of the pendulum and the distance apart of centres of spheres were obtained, the sphere on the rod, of 1 cm. radius, was removed and a charged sphere of 4.6 cm. radius was brought opposite the charged pendulum. The deflection of the latter was now 3.5 cms.; the distance of centres of spheres 28.5 cms., and the force of deflection in dynes 10.29. The quantity, Q′, on larger sphere is

$$Q' = \frac{fD^2}{Q} = \frac{10.28 \times 812.25}{19.7} = 424.26$$

units of quantity.

As the potential (V) of the larger sphere is equal to the quantity (Q′) of its charge divided by its capacity (C), or radius in centimeters, we have

$$V = \frac{Q'}{C} = \frac{424}{4.6} = 92.2 \text{ units of potential.}$$

The foregoing experiments show that the pendulum-electrometer gives the law of inverse squares, serves to determine the law of dissipation of electric charge, and with it one may make measures of the electrical distribution on conductors and determine quantity and potential. In short, this simple apparatus affords an inexpensive and ready means of presenting clearly to students the nature of measurements of static electricity; and allows one to make these measures in absolute units before a class with ease and dispatch.

Stevens Institute of Technology, Hoboken, N. J.

NEW HAVEN, CONN.—THE New Haven Electric Company are making arrangements for a complete new station, which will be situated on the shore at Fairhaven. It will be constructed on the Thomson-Houston system throughout, and compound condensing engines will be used, with Babcock & Wilcox boilers. The new station will supply all the arc light circuits in New Haven, and about 2000 incandescent lamps, while the old station will be given up entirely to the incandescent business, which is rapidly increasing.

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[4] Sixième Mémoire sur l'Électricité, Mem. de l'Acad. Sci., 1788, p. 628.

CORRESPONDENCE.

NEW YORK AND VICINITY.

The Board of Electrical Control—A Simple Explanation of the Keely Motor—Close of the Edison Electrical Exhibition—Electric Roads for Brooklyn.

THE Board of Electrical Control has had some more meetings, but without much result. At the session on May 16th, the United States, the Brush, and other electric light companies withdrew their applications for ducts they had previously made, for the purpose of revision. The revised applications will be presented to the Board this week. There is a dispute between the Board and the Police and Fire Departments with regard to the occupancy of ducts without charge. The two departments do not want to be "ducted" together. Each wants a duct of its own.

The Board has had its existence lengthened for one year, by a bill passed by the last Legislature, at the request of Commissioner Hess. It is believed that the governor will sign the bill.

The New York *World* has had an interview with Keely, the mysterious motor man. The inventor very frankly told the reporter the whole modus operandi of his wonderful discovery. Here is the pith of the whole matter as divulged by Mr. Keely himself: "There is a triple sympathetic order of vibration diverting the positive and negative currents to one general polarized centre; this rotary action is continuous when sympathetically associated with the polar stream."

The Edison Electrical Exhibition in aid of the Women's Exchange was brought to a very successful close last week. It is understood that several thousand dollars will be netted. A bit of interesting news is that the exhibit will be transferred bodily to the Great Northwestern Exposition at Minneapolis, where the old effects will be reproduced on a larger scale and many new ones added.

The application of the Brooklyn City Railroad Company for permission to substitute electric motors for the horses now used on its cars means a great deal more than appears on the surface, and is probably the first step towards the adoption of that system of locomotion by every surface road in town. The City company is the largest horse-car concern in this country. It controls over 600 miles of tracks and has a transfer system which connects all parts of the city. When electricity is finally introduced this transfer system is to be still further enlarged, and the time occupied in traveling about town will be very materially reduced. President Lewis, who has been urging the substitution of electricity for horses for a long time, is very enthusiastic over the prospect of getting it on his roads. "It is the coming power," he said the other day, "and we propose to utilize it. In all probability we shall have two power stations, so that we shall not be inconvenienced if one blows up. I am very strongly in favor of supplying power from one central station to all the roads that will use electric motors. That would reduce the cost to a minimum." In view of the interest in the subject, the Brooklyn Institute invited Mr. T. C. Martin to lecture before the Institute last week, and accordingly, Saturday evening was devoted to "The Electric Railway in its Social and Scientific Aspects," when a large audience gathered. Mr. James Hamblet presided. The lecturer based his address chiefly on the paper recently read by him before the New York Electrical Society. A large number of views were exhibited by lantern, showing the arrangement of the motors, the methods of line construction, etc. A number of new views never before shown were also exhibited of roads and cars of the Sprague, Thomson-Houston, Daft, Julien, Rae, Short and other systems.

NEW YORK, May 19, 1890.

BOSTON.

Grand Jury Acquit Sizer—Lecture by F. S. Pearson—Electric Legislation—Elevated Railroad Bills all Tabled—West End Increase—Meeting of the American Institute of Electrical Engineers in Boston—Complimentary Dinner to the Members by the Boston Electric Club.

IN the report of the Grand Jury no bill was found against D. W. Sizer, the driver of the West End Car, which hit the horse on which the late Mr. G. H. Bradford was riding, when the latter was thrown and killed. The Grand Jury has had the matter of indicting Sizer under consideration for the past two months.

Mr. F. S. Pearson, electrician of the West End Street Railway, gave an interesting talk this week before the Parker Memorial Science Class, his subject being Electricity and Electric Cars. Mr. Pearson's explained by diagrams the construction of electric generators and motors, and explained the single and double trolley system. He claimed that the 500 volt current generally used for railway purposes was entirely harmless and could not possibly kill anyone.

The committee on manufactures reported "ought to pass," with amendments, on the bill to permit the consolidation of gas and electric light companies. One amendment is that the agreement for consolidation shall be executed by the presidents of the constitutent companies only after it has been approved by vote of two-thirds in number and interest of the stockholders of each corporation, at a special meeting. Instead of "majority of the appraisers" fixing the capital of the new corporation, the "appraisers" may do it.

The committee on mercantile affairs has been given some very interesting hearings on legislation growing out of the conflict between the two electric light companies at Middleboro. The trouble there is alleged to have resulted from the course of the gas commissioners in encouraging both companies to go ahead. The bill which the committee has under consideration provides that in any city or town in which a company is engaged or organized for the purpose of the manufacture and sale of electric light and power, and in which, with such company, the city or town has made a contract to light its streets, and has given its consent to such company to lay, erect or maintain wires over or under the streets, lanes and highways, and such company has laid, erected and maintained such wires, the consent heretofore given for the purposes aforesaid is thereby confirmed; and such company is authorized to lay, erect and maintain such wires; provided, however, that this act shall not exempt such company from any duty required by the general laws in relation to the manufacture and sale of electric light and power. In Middleboro, the local authorities support the local gas company, which also furnishes electric light, while the commissioners licensed another company finally. For this reason a general law is desired.

A bill has been reported to authorize the Nantucket Electric Street Railway Company to do business as a common carrier.

The elevated railroad bills all received attention this week, and at one time it looked extremely probable that the West End bill would go through, all the other bills having been tabled. The street railway committee actually did report a bill allowing the West End company to construct and equip an elevated railroad. The latest report, however, from the State House, states that the bill has been tabled along with the others, and it is not likely to come up again for some time.

The selectmen of Brookline gave a public hearing on the petition of the West End Street Railway Company for leave to construct, maintain and use a double track on Chestnut Hill ave., beginning at the dividing line between Boston and Brookline on and running southerly on Chestnut Hill ave., with curves into a proposed car house about to be erected by the company; also for leave to operate the company's cars on the proposed tracks by the overhead single trolley electric system of motive power, and to make the underground and surface alterations of the street, and to erect, maintain and use poles, wires and electrical appliances necessary for that purpose.

The American Institute of Electrical Engineers will hold its general meeting at the new building of the Massachusetts Institute of Technology, Boston, on Wednesday, May 21st, at 10 o'clock, when some very important papers will be read on various electrical topics, by some of the brightest men in the electrical profession. On Wednesday evening, the members of the Institute will be the guests of the Boston Electric Club at a dinner, to be served at the Parker House, at 6.30 o'clock. A paper will be read under the auspices of the Club, by S. E. Barton, of Boston; on "The Relation between Fire Insurance and Electric Interests, from the Underwriter's Standpoint."

The headquarters of the Club are at 7 Park Street, where members will be welcome during their visit to the city.

On Thursday there will be parties organized to visit the electrical factories in the vicinity, and members and friends should avail themselves of the opportunity.

BOSTON, May 17, 1890.

CHICAGO.

The Sprague Electric Road.—To Avoid Manhole Explosions.—Speed in Milwaukee.

THE electric street railway on the west side, which is being built by the Sprague company, is now being rapidly pushed ahead, and work on the power house which is located on Lake street, between Ridgeland and Austin avenues—is going forward as fast as possible. The line starts at 40th street, and runs west on Madison street to Oak Park, then across to Lake street and back east, joining the starting point again. There are about nine miles of road to be equipped of which eight are double track. The road is expected to be in operation by October 1st, and will add greatly to the rapid transit facilities of Chicago.

Improbable as it may seem, things are going too swiftly in Milwaukee, and an ordinance to correct the evil will shortly be presented to the common council. The city never had the reputation of being any too rapid, and the street cars there were supposed to be only a trifle slower than the Supreme Court. But it is the street cars that are too swift now. When the ordinances under which the new electric street railway companies now operate were passed, there never was any idea that street cars could go too fast. It was anything to be faster than the mule teams on the bob-tail cars. The result was the passage of ordinances allowing electric street railway cars to run as fast as possible—the faster the better was the general sentiment when the ordinances were passed. The result is that electric cars are now tearing through the city like a wild steer in a corn field and an ordinance will shortly be introduced which will regulate the speed of the cars, particularly in the business section. Mayor Peck favors such an ordinance and will do all in his power to have the electric cars placed under a control compatible with the safety of passengers and pedestrians.

Commissioner of Public Works Purdy has sent to all underground wire companies in Chicago, a communication requesting them to take the necessary precautions to prevent explosions in man-holes. Mr. Purdy suggests that the companies consult Prof. Barrett, who has devised a means of preventing such explosions.

CHICAGO, May 16, 1890.

ST. LOUIS

Electric Railway Work.—New Western Union Office.—St. Louis Conduit Company.

THE Missouri Railroad Co. and the Forest Park, Laclede and Fourth Street Railroad Co. have jointly closed a contract with the Thomson-Houston Electric Co. for the equipment of 15 miles of road and 36 motor cars. The Market street line of the Missouri Co. will be extended from Tower Grove station on the Missouri-Pacific Railway to Shaw's Botanical Garden and Tower Grove Park. The Missouri Railroad Co. have increased their capital stock from $900,000 to $2,400,000.

The Southern Railroad Co. have contracted with the Thomson-Houston Electric Co. for 24 motor cars. Relaying and wiring of track is now going on from both ends of the road, and poles are being erected on the up-town end. The road has a mileage of eight miles of double track extending from Market street to Carondelet. A bill has been introduced before the Municipal Assembly authoring this company to operate its road north of Market street by electric power.

The new power station of the St. Louis Electric Power Co. started up last Friday, the 5th. The station is located on Morgan street, between 2d and 3d, and consists of a substantial brick building, one story in height, covering a ground space 63 x 108. The boiler room 63 x 48, contains two tubular boilers 66 x 16, aggregating 250 h. p. The dynamo room contains one Westinghouse engine of 125 h. p., and one Russell engine 150 h. p., one 80,000 watt and four 30,000 watt Edison dynamos.

The Western Union Telegraph Co. have taken a 25 year lease on the Lucas Building, at a rental of $4,500 per annum. The telegraph company are to expend $20,000 on the building. The building is four stories high, has a frontage of 40 feet on Pine street and a depth of 140 feet, with a city alley on one side and a private alley on the other side.

The St. Louis Conduit Co. has been incorporated with a capital stock of $250,000. The incorporators are John M. Sellers, Jacob C. Ewald and Henry W. Bond.

ST. LOUIS, May 14, 1890.

PITTSBURGH.

Police and Fire Bureau Wires.—Lighting the City of Allegheny.—Stanley-Slattery Litigation.—Electric Mining in West Virginia.

THE wires of the police and fire bureau are to be changed in this city. Supt. Mead, of the department of electricity, has just been allowed to spend $3,000 in making the change. He says that the large number of electric railway wires in the city has greatly interfered with the telephone system and something had to be done to prevent their entire uselessness. Mr. Mead intends to substitute two twisted wires, where one is now used, and he hopes to thus obviate any further trouble.

The Westinghouse electric light plant in the city of Allegheny, is rapidly nearing completion. All the towers, and there are to be 52 of them, are almost put up, as well as the mast arms for the arc lights and it is expected that the plant will be in active operation July 1.

Judges Bates, Clark and Stocking rendered their decision a few days ago in the Stanley-Slattery litigation case regarding a patent on alternate current system of electrical distribution. Mr. Stanley's patent belongs to the Westinghouse Electric Co. and Mr. Slattery is the electrician of the Fort Wayne Electric Co. In their decision, the judges stated that they believed Mr. Stanley to have conceived of the invention and brought it into commercial utility before Mr. Slattery reduced it to practice. This confirms the decision rendered some time ago by Commissioners Johnson and Morris.

The first electric mining plant in the state of West Virginia, was put up a few days ago at Thurmond, Fayette county.

PITTSBURGH, May 17, 1890.

THE NATIONAL ELECTRICAL MANUFACTURING CO., the successors to the electrical department of the New Haven Clock Co., moved to their new quarters, 14 and 16 Vesey street, on May 12.

LITERATURE.

Electrical Engineering for Electric Light Artizans and Students: By W. Slingo and A. Brooker. London and New York. Longmans, Green & Co., 1890. 307 illustrations, 631 pages. 4⅛ x 7⅛. Price, $3.50.

THE Admirable Crichton of the electrical field is rapidly becoming as extinct as the dodo. There was a time, and not long ago, when a man might fairly claim with an easy conscience and a cheek of ordinary hue that he was familiar with the whole round of electrical science and invention. To-day work as he will, and even though he possess the memory of a Macaulay or the assimilative powers of a Webster, or the quick grasp of fundamental principles of a Faraday, he must admit that in some departments of the vast field of electrical knowledge his training and expertness are superficial. In fact the whole drift of his work, if he aims at success, will be distinctly towards specialization.

Nevertheless, and because of this state of affairs, the need grows for comprehensive treatises on electricity, of a kind that an intelligent student may readily master, so that even if he does not come in actual contact with the apparatus and appliances described, or does not have occasion to employ in their most perfect outworkings the principles enunciated, he has a tolerable familiarity with the subject, and is able to follow with appreciation all the work that is being done.

The present work is a highly creditable example of the modern electrical compendium and encyclopædia in brief, and may be given to any student or workman with confidence as to the good results it will produce. It ranges over the whole field and no subject is touched upon that is not rendered intelligible and interesting. No one can read this book through with mind intent and desirious of learning, who will not be able thereafter to think and speak intelligently of well nigh every branch of heavy electrical engineering recognized to-day. It does not, however, include telegraphy or telephony. There is warrant for this, but we think that these two fields of work have some claim to recognition under the generic title of the book.

In view of the variety of subjects touched upon, the work is remarkably free from mistakes. We must take exception, however, to the statement on page 546, that the Edison lamp is rarely used now. As every body knows, there are hundreds of thousands in use in America, the number growing yearly. Even if the statement were meant to apply to England it would not be true, because such lamps as are made there are virtually all made under Edison patents to a greater or less degree. With regard to electric railway work, the book is also a little deficient and inexact. While the enormous development in America is hardly noticed, Holroyd Smith's work, and that at Northfleet comes in for extended description. Now it is quite right to give Holroyd Smith and Northfleet their due, but the work done in America is of vastly greater importance.

These are details, however, and are more than offset by many excellences, not the least of which is the careful enunciation of principles and fundamental ideas, and a trustworthy exposition of the latest teaching on moot points. The book is beautifully printed, and has an index that will stand testing.

SOCIETY AND CLUB NOTES.

NEW YORK ELECTRICAL SOCIETY.

THE annual meeting of the New York Electrical Society was held at Columbia College on May 15, when the secretary, Mr. G. H. Guy read his annual report, and officers were elected. The report is as follows:

The work of the Society has been steadily progressing during the past year. The number of members now on the roll is 250. During the year 40 new members have been elected, and there have been four resignations, so that the net gain in membership is 36.

The Society has been able to provide an excellent course of lectures, which have not only been received with appreciation by the members and their friends, but have secured from the press a recognition which is gratifying and encouraging.

A recapitulation of the subjects treated of at the various meetings will enable you to judge of the manner in which the Society has endeavored to carry out its work.

Mr. W. J. Jenks gave a paper on the "Practical Working of the Edison Three-wire System;" Mr. A. A. Knudson spoke on "Electrical Exhibitions," and Mr. Joseph Wetzler told of what they are doing in electricity in Europe. Our worthy president lectured on "How to Test Electrical Motors;" Mr. S. Dana Greene gave us "The Development of Electric Street Car Traction;" Mr. Joseph Wetzler ushered in 1890 with his lecture on "The Electrical Progress of the Year," which has now become a recognized feature in the Society's programme. Mr. Herbert Laws Webb broke new ground in his paper on "The Construction and Laying of Submarine Cables," and a very full house attended the "Phonograph Evening." Mr. T. C. Martin read a paper on

"The Social Side of the Electric Railway." In consequence of the number of inquiries about this paper, the society has been induced to publish it, and several thousand copies have been sold at cost, to the leading electric railway companies in the country, for missionary purposes. By way of giving a practical exposition of the alternating current, a subject that is now attracting such universal attention, the Society called its members together one evening at the Equitable Building, and the Westinghouse company made them welcome at its exhibition plant there. The last meeting was held at the Lenox Lyceum, to inspect the fine collection of Edison inventions and apparatus, and a large number availed themselves of the opportunity of seeing the beautiful electrical exhibition there.

For the next season the executive committee has in contemplation plans which it is hoped will more than maintain the prestige and influence which the Society has so honorably gained during its many years of existence as the oldest body of the kind in the country. In the course of lectures that will be provided, the Society will engage the subject of electricity on its popular and educational side. There is now a great popular demand in this city for information on everything that pertains to electricity, and the Society stands between the electrical inventor and engineer, and the public, helping alike the student who knows something of electricity, and the citizen who knows nothing at all, and feels helpless in his ignorance.

There is a wide educational field open, and in this field the Society proposes to largely increase its work.

I cannot close this report without a reference to Columbia College, in whose hall we meet to-night. It is gratifying to see that this seat of learning is discharging its duty to the fullest degree when, in addition to following out the developments of higher education it places itself in touch and closest intimacy with such a Society as this, which seeks to make the latest researches of the scientist and the investigator common property and a benefaction to all

The Society feels deeply grateful to Columbia College for the hearty encouragement and support given to it, and trusts that the ties thus formed may increase and be strengthened.

Prof. F. B. Crocker was re-elected as president. Messrs. J. Wetzler, Francis Forbes, Dr. O. A. Moses, T. C. Martin, G. H. Stockbridge and E. L. Bradley, were elected vice-presidents, the first three being re-elected. Secretary G. H. Guy and treasurer H. A. Sinclair were re-elected. Messrs. C. O. Mailloux, J. Wetzler and F. B. Crocker were elected as trustees.

After this business had been dispatched, Mr. J. J. Carty, electrician of the Metropolitan Telephone and Telegraph Company, read a most interesting paper on "Telephone Engineering," which will be found elsewhere in our columns. It elicited an instructive and lively discussion, in which Messrs. Wintringham, Hammer, Pupin, Moses, Mailloux, Wetzler and several others participated.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued May 13, 1890.

Alarms and Signals:—*Fire-Alarm Regulator*, C. J. Spike and H. V. McLeod 427,711. *Electric Signal*, J. Haas, Jr., 427,762.

Clocks:—*Electro-Pneumatic Clock System*, C. A. Mayrhofer, 427,781.

Conductors, Conduits and Insulators:—*Electrical Conductor for the Transmission of Power*, W. J. Cordley, 427,746. *Terminal for Electric Cables*, J. A. Hanagin. 428,046. *Manufacture of Telegraph Cables*, W. R. Patterson, 428,055.

Distribution: *System of Electrical Distribution*, L. Bell, 427,541. *Alternating Current Apparatus*, E. & F. W. Heymann, 427,571. *Electrical Converter*, S. Z. de Ferranti, 427,751.

Dynamos and Motors:—*Carbon Brush for Motors*, L. Daft, 427,674. *Alternating Current Motor*, M. Von Dolivo-Dobrowolsky, 427,978. *Commutator-Brush*, E. H. Bowen, 428,038.

Lamps and Appurtenances:—*Incandescent Electric-Light Bulb*, T. B. Atterbury, 427,951. *Lantern for Electric Arc Lights*, J. W. Gwinn, 427,986. *Arc Lamp*, P. Lange, 428,008.

Measurement:—*Electric Meter*, S. C. C. Currie, 427,748. *Method of Measuring and Registering Electric Energy*, S. C. C. Currie, 427,749.

Metal-Working:—*Method of Electric Welding*, C. L. Coffin, 427,971.

Miscellaneous:—*Lightning Arrester*, L. Bell, 427,540. *Fuse-Block*, C. F. Brush, 427,548. *Electric Prod-Pole*, J. M. Burton, 427,549. *Electric Heater*, B. C. Howard, 427,574. *Electro-Magnet*, F. J. Patten, 427,606. *Electro-Matrix Machine*, G. A. Goodson, 427,681. *Automatic Electric Cut-Out*, E. M. Bentley, 427,724. *Fuse-Plug*, W. A. Anthony, 427,823. *Automatic Lightning Arrester*, C. M. Griffin, 427,984. *Method of Producing Alternating Electric Currents*, M. S. Conly, 428,042. *Ground Detector*, C. H. Macloskie, 428,050. *Pyro-Magnetic Electric Generator*, N. Tesla, 428,057.

Railways and Appliances:—*Trolley Arm for Electric Cars*, W. F. Harriman, 427,569. *Guide for Trolley-Wheels*, H. A. Marks, 427,589. *Trolley or Collecting Wheel for Electric Railways*, S. H. Short, 427,628. *Electric Railway*, E. M. Bentley, 427,725. *Contact Device for Electric Railways*, E. M. Bentley, 427,726. *Electric Circuit Closer for Railway-Signals*, F. E Morgan and F. A. Lane, 427,783. *Electric Train-Signaling Apparatus for Railways*, E. J. J. de Baillehache, 427,958. *Motor-Car*, G. M. & J. A. Brill, 427,966. *Track-Instrument for Railroad-Signals*, M. S. Conly, 428,041.

Secondary Batteries:—*Composition for Supports for Secondary Battery Electrodes*, W. F. Smith, 427,710. *Secondary Battery Electrode*, J. F. McLaughlin, 427,785. *Secondary Battery*, T. F. Nevins, 427,789.

Telegraphs:—*Telegraph Key*, J. S. Kaylor, 427,876.

Telephones and Apparatus:—*Multiple Switch-Board Test System*, C. E. Scribner, 427,621. *Switch-Board*, C. E. Scribner, 427,622. *Test-Circuit for Multiple Switch-Boards*, C. E. Scribner, 427,623. *Multiple Switch-Board Test-Circuit*, C. E. Scribner, 427,624. *Telephone Exchange Apparatus*, J. J. Carty, 427,742. *Multiple Switch-Board*, C. E. Scribner, 427,917. *Means for Effecting Communication in Telephone Systems*, L. J. Crossley and W. Emmott, 427,974.

PATENT NOTES.

PROF. FORBES' CARBON BRUSH.

THE issuance of a patent on the carbon brush as employed so extensively for dynamos and motors at the present time has created considerable interest. The patent which was granted to PROF. GEORGE FORBES, of London, describes a brush composed of carbon electro-plated with copper and strengthened by a backing of copper. The patent, entitled "Electrical Collecting Device" No. 427,259, was issued on May 6,1890, and its claims are as follows:

1. A contact maker or brush for establishing electrical connection with parts in rapid relative motion—such as the collectors of dynamo-machines—consisting of a plate of carbon, substantially as described.
2. A contact maker or brush for establishing electrical connection with a rapidly-moving contact-surface of metal, consisting of a carbon plate.
3. A contact maker or brush for establishing electrical connection with a rapidly-moving contact-surface, consisting of a plate of carbon backed with metal, substantially as described.
4. In combination with the commutator or collector of an electric machine, a contact-brush consisting of a plate of carbon and a metallic coating electro-plated thereon.
5. A commutator-brush for a dynamo-machine or electric motor, consisting of a plate of carbon and a metallic coating electro-plated on said plate, substantially as described.
6. A commutator-brush for a dynamo-machine or electric motor, consisting of a plate of carbon, a metallic coating electro-plated thereon, and a metallic plate fastened to such electro-plated coating.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

COOLING THE STAR THEATRE, N. Y., WITH CROCKER-WHEELER MOTORS.

MR. THEODORE MOSS, proprietor of the Star Theatre, corner of Broadway and Thirteenth street, after considering various plans for cooling the auditorium of the theatre during the performances in the summer months, has adopted the plan submitted by The Crocker-Wheeler Electric Motor Co., of Fourteenth and Washington streets, through Mr. McCoubray, their secretary and general sales agent. A trial of the apparatus on Monday, May 12th, in the presence of Mr. Moss and his staff, demonstrated the complete success of the plant, and the patrons of the theatre during the warm weather will find the temperature as pleasant as may be found at Newport, no matter what the temperature may be on the outside.

The plant consists of a large Crocker-Wheeler electric motor and an immense pressure blower—an ice-chamber of tremendous proportions—various ducts leading to the auditorium, and numerous registers for controlling the flow of air. One of the peculiarities of the system is the construction of the ice-chamber, which is so arranged that the drippings of the water from the ice are utilized to cool the air before it comes in contact with the ice itself.

The system is an assured success, and will keep the atmosphere of the theatre in a delightful condition, even without the use of ice. It is proposed to use ice, only when necessary, in extremely hot weather.

When it is considered that a volume of 25,000 cubic feet of air per minute at a temperature much lower than the outside air, is forced into the auditorium, we are constrained to believe that we can take our pleasure at home instead of being forced to the sea-shore.

It is believed, too, that this is but the foundation of a system by which cool air will be delivered into houses throughout cities and towns as we now receive our water, our light, our gas, and our heat. When the several small electric fan motors ordered by Mr. Moss (and which are a part of the system) are placed in position, the plant will be complete as designed by Mr. McCoubray.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY.

This company has been driven by the growth and pressure of its business to take larger quarters, and has moved into 24 Cortlandt street, where it has engaged the whole first floor, stretching clear through to Dey street upon which it also has an entrance. The floor is being divided off into departments. Mr. Seely and Mr. Taylor have their office and clerical force in front, overlooking Cortlandt street. The book-keeping force is at the Dey street end, and the underground department has quarters midway between. Racks are provided for plans, etc. of all the work done or in hand, and all classes of supplies are conveniently placed in bins and lockers. The company has been doing an enormous business and considers it nothing unusual to have as many as 300 men occupied at once on its various installations. The Seely & Taylor Manufacturing Co. is also located at No. 24, and is getting ready to meet the inevitable big demand for its rubber molding and other ingenious and patented specialties.

H. E. & C. BAXTER.

THE above well known firm, of 18 Fulton street, Brooklyn, manufacturers of electrical goods, have just issued a new and very tasteful catalogue and price list of their annunciators, bells, electro-magnets, push buttons, batteries, zincs, name plates, letter boxes, burglar alarm window springs, &c. Their iron box bells are well illustrated and described, and merit the notice of all buyers of this line of supplies. It will be remembered that in the Baxter hotel annunciators, of which cuts are shown, the gravity drop is used, for which many advantages are claimed on account of the absence of springs and the simplicity of construction. The goods of the firm are noted for their handsome design and excellence of workmanship, and there can be no doubt that this catalogue will help to stimulate the demand for them.

NEW WESTINGHOUSE PLANTS.

LOS ANGELES, California, the beautiful "City of the Angels," is to have a new electric lighting plant, and the Company use the Westinghouse alternate current system. The initial capacity of this plant will be fifteen hundred 16 c. p. lamps, and the work of construction is to begin immediately. Los Angeles is in many respects a paradise, but of course is not exempt from the darkness which visits every corner of the globe for a portion of each day. The capitalists of the city are wise to invest their money in furnishing electric illumination and their enterprise will certainly be appreciated.

LAS VEGAS, New Mexico, might be called an out of the way town. But evidently it would be unjust to charge the citizens of the place with lack of enterprise. A company has been formed there to go into the electric lighting business and a representative of The Westinghouse Electric Company recently sold to it a five hundred light incandescent machine of this company's manufacture together with one of the new alternate current arc lighting dynamos of forty lights capacity.

YOUNGSTOWN, Ohio, is to adopt the alternating current incandescent system. The Westinghouse Electric Company recently sold to a newly formed corporation in that thriving young manufacturing city a twenty-two hundred and fifty light plant. It is the intention to push the work of installation to completion with the least possible delay.

THE VENEZUELA & ELECTRICAL APPLIANCES COMPANY.

THE Venezuela & Electrical Appliances Company (limited) is bringing out its securities in London. It is the purchaser of the franchise, etc., of the Intercontinental Company of Boston, as lately stated. The Venezuela company has a capital of £70,000, £1 shares, which it issues, with £70,000 5 per cent, first mortgage bonds, the latter at 85 per cent. It pays the Intercontinental company, according to the prospectus, £55,000 of the bonds and £60,000 of the shares or the proceeds thereof.

ALTERNATING ARC LIGHTS.

THE Westinghouse Electric Company has issued a very handsome and complete illustrated pamphlet on its new alternating arc lighting system. The descriptive matter is excellent, and the cuts are of the first order of merit. The cover is handsomely embossed and silvered.

THE TROPICAL AMERICAN TELEPHONE COMPANY.

THE Tropical American Telephone Company has closed a contract with the governor-general of Cuba for 100 sets of instruments and a large lot of supplies, the Cuban government having taken over the telephone business formerly operated by the Compania Electrica de Cuba. An order for 500 complete sets has also been received from Rio de Janeiro.

The Tropical company have just issued a very important pamphlet on "Telephone Rights," and a careful perusal of this is recommended to all exporters of telephonic apparatus. It will be seen that the Tropical company have the *exclusive* right to sell genuine Bell telephones in Central America, South America and the West India Islands, and all companies exporting instruments to these countries have "got to buy" their apparatus from the Tropical company whatever reports may be made to the contrary. The American Bell Telephone Company continue to supply the Tropical American Telephone Company *exclusively* with instruments for the above countries, as it did the Continental company originally.

THE NEW YORK INSULATED WIRE COMPANY.

AFTER a trip of unusual length, and corresponding success, Mr. J. W. Godfrey, the general manager of the above company, has returned home to headquarters at 649 & 651 Broadway, this city. He reports an excellent condition of trade through the west, and has done much in the way of establishing the new agencies necessary to handle and distribute the large amount of wire, cable, tape &c. now called for. The list of selling agents now comprises the following: Southwestern Electrical Supply Co., Kansas City Mo.; Knapp Electrical Works, Chicago, Ill.; St. Louis Electrical Supply Co., St. Louis, Mo.; the Central Thomson-Houston Co., Cincinnati, O.; Kendal & Slade, Boston, Mass.; Fisher Electric Co., Detroit, Mich.; Dayton, Hall & Avery, Portland, Oregon; Thos. F. Day & Co., San Francisco, Cal.; North-west Thomson-Houston Co., St. Paul, Minn.; Southern Electrical Mfg. & Supply Co., New Orleans, La.; Bagnall & Hillas, Yokohama, Japan.

THE ELEKTRON MANUFACTURING COMPANY.

THE above company, of Washington street, Brooklyn, are enjoying a great run of business, and in order to keep pace with the demand for their motors and dynamos have been compelled to enlarge their factory and increase their facilities for production. Their motors are being used to-day upon work of the utmost variety and the testimonials as to their merit are neither few in number nor ambiguous in tone. Mr. E. H. Cutler, the treasurer and manager, has in hand a very interesting pamphlet on their Perret motor and its uses in connection with primary and secondary batteries or with dynamo current. The company's slow running dynamos have also won hearty approval as generators for light and power, and a specialty is now being made of isolated plants for incandescent lighting. Mr. Perret, the electrician of the company, is engaged upon a number of interesting improvements and developments, all of which will mature in time.

THE NATIONAL ELECTRIC TRACTION SYSTEM.

THE Detroit Electrical Works have been extremely busy equipping roads with the National Electric Traction System worked out by Mr. F. B. Rae, who is well known as one of the pioneer electric railway builders of this country. They have already equipped roads as follows:

Fort Worth, Texas, Land & Street Railway Co., 15 cars, four 50,000 watt generators.

Saginaw, Mich., Union Street Railway Co., East Saginaw, 25 cars, four 65,000 watt generators.

Adrian, Mich., Electric Street Railway Co., four cars, two 35,000 watt generators.

Citizens' Electric Street Railway Co., Elkhart, Ind., five cars, two 35,000 watt generators.

Decatur, Ill., Electric Street Railway Co., 4 cars, two 65,000 watt machines.

They are also equipping the Sault Ste. Marie, Mich., Street Railway with 4 cars and one 65,000 watt generator; the East Detroit & Grosse Point Railway with 6 cars and two 65,000 watt generators; and the Highland Park Railway, Detroit, with four cars and two 65,000 watt generators.

In all the above, the plant has been made large with a view of increasing the car equipment. Mr. Rae is using in nearly every instance a single motor of 30 h. p. geared direct to both axles, and he is satisfied that his method is the most economical as regards first cost and maintenance and in avoidance of friction loss, when compared with any of the double motor arrangements.

P. A. DOWD & CO.

MESSRS. P. A. Dowd and G. W. LaRue, at present associated under the firm name of P. A. Dowd & Co., the well known agents of the Sprague Electric Railway and Motor Co., have mutually agreed to dissolve partnership, to date from June 5.

THE GREAT WESTERN ELECTRIC SUPPLY CO.

Mr. Geo. Cutter has now definitely located his new quarters at 190—192 Fifth ave., Chicago The building which he has leased and which will be filled with general supplies of all kinds "right away," is 42 x 90 feet and comprises five floors and basement and is very desirably situated for the immense business which Mr. Cutter intends doing. One smallitem of three carloads of Simplex wire is already on its way, and Mr. Cutter expects to move in early next week.

Important developments will be immediately made and the business pushed to its fullest extent. Arrangements have been made with a large syndicate which will be named The Great Western Electric Supply Co., to open branches in several important cities, and supplies of the finest class will be carried in stock in large quantities enabling all orders to be executed with the utmost promptitude. We wish Mr. Cutter well deserved success in his new departure, which will be one of the largest ever carried out in the supply business and we are confident that by reason of his large business experience, and executive ability together with his widely known qualities as a "hustler" all over the country, an enormous success awaits him.

THE EASTERN ELECTRIC CABLE COMPANY.

The Eastern Electric Cable Company of Boston have issued a neat little price list of their far famed Clark wires. One of the special features about the Clark insulation is that it is chemically prepared in such a manner that it is perculiarly able to resist all oxidizing. In the price list they call attention for the first time to their latest production, the "Hub" line wire. This wire is designed for use among trees, and wherever a superior line wire is required. The wire is covered with a thin layer of the ordinary Clark compound, and protected by two heavy braids, coated on the outside with a special waterproof solution, which makes it very hard and durable, and capable of withstanding a large amount of abrasion. Modesty has prevented the Eastern Electric Cable Company from appending numerous testimonials, and the pamphlet is entirely devoted to price lists, and a few useful formulae.

TESTED SAFETY FUSES.

With the view of determining the "safety" of the fuses and fuse wires now on the market, the Massachusetts Electrical Engineering Co. have made a series of elaborate tests on them. The results of one series of these tests and the conclusions reached were published in this paper last week.

The company now places on the market, through its supply department, a fuse which, it claims, fills the requirements of a safety fuse. That is, its fusing point is independent of the surrounding temperature, or of its position (open air or closed box). The disadvantages which it has been the aim of the designers of this fuse to overcome are the variation of fusing-point with length, position, and temperature of surrounding air, as well as the violent spluttering and throwing of melted metal. These new fuses are called the "American Safety Fuses." They are made of a strip of an alloy foil, mounted on asbestos, and coated through the centre on the foil side with an asbestos compound.

The exposed portion of the foil is thus surrounded by asbestos, which prevents any loss of heat by radiation when heated by an undue increase in current. The centre of the foil becomes the hottest, and the foil breaks without injuring the binding posts or even breaking the asbestos support.

These fuses are packed in boxes of 100 each, of various lengths and grades. They are carefully tested and the boxes marked with the results of the tests. At present the company are not making these foil fuses in the larger carrying capacities, but are supplying in all sizes a superior grade of tested fuse wire. Each spool of this wire is tested at several points, and a certificate accompanies each coil or spool sold, giving the following data:

Advisable carrying capacity:—
 Fusing point in open air of a 1 inch piece.
 Fusing point in open air of a 2 inch piece.
 Fusing point in closed box of a 1 inch piece.
 Fusing point in closed box of a 2 inch piece.

THE EVANS FRICTION CONE.

The Evans Friction Cone Company continue to receive the warmest testimonials of their friction system of driving dynamos direct from engines. In a letter recently received from the Hutchinson Light and Power Company, of Hutchinson, Kans., where they are using the Evans system, the manager writes that he is more than satisfied with the result, and he points out several important features. He can use two dynamos on one engine, and yet shut down any one dynamo, without interfering with the other. A dynamo can be stopped more simply than by clutches; there is no lost motion even under full load, and the pressure on the bearings is even less than if belts were used. Mr. L. A. Beebe of the Morgan Engineering Company, of Alliance, O., who has been using the Evans system for some time on a few of their dynamos, writes that he now intends to use it on all. The new station of the Attleboro Electric Light Company, Attleboro, Mass., using the Evans system, has now been started up, and the writer had the pleasure of seeing the system in use a few days ago. Besides running electric light dynamos, the two generators for the electric railway are also driven by the Evans system, and Mr. H. M. Daggett, Jr., states that he is entirely satisfied with it.

NEW ENGLAND TRADE NOTES.

J. A. Grant & Company, of Boston, have sold a 500 h. p. McIntosh & Seymour engine for the St. John Electric Railway Company, St. John, N. B. The railway system is being changed from horses to electric power, though the system has not yet been fully decided. The McIntosh & Seymour engine is meeting with great success in New England as an economical and reliable machine, and Messrs. Grant & Company are finding a large field for them among the numerous electrical enterprises.

The West End Street Railway Company have given permission to Mr. W. D. Swart to put in on their system one of his automatic electric switches, a model of which is to be seen in the office of the Wheeler Reflector Company of Boston. The action of the switch depends upon an electro-magnet under the surface of the street, operated by powerful electro-magnets carried on the car.

The Connecticut River Railroad are running a train lighted throughout by electricity. The Barrett system of storage battery is used, and Jordan train couplers connect the different cars.

The Standard Electric Company of Vermont has sold a 200 light dynamo for use on board the S. S. "Winthrop," a steamer running between Bar Harbor and New York.

Brown Electric Protector Company.—Mr. W. H. Smith of this company has just filed patent papers for a new and improved device to be applied to the Brown protector when used on metallic circuits. By means of the device, should a wire between any two instruments which are protected become crossed with an electric light or power wire, it is immediately cut out, and a ground circuit is used in its place between the two instruments, thus enabling the circuit at all times to be serviceable.

Beacon Vacuum Pump and Electrical Company has been organized in Boston with a capital of $1,000,000, with Mr. Jacob Heilborn, president, and Mr. Lewis E. Whicher, secretary and treasurer, and a strong board of directors. The company has been formed for the purpose of developing the Berrenberg vacuum pump, recently described in The Electrical Engineer, which is attracting a great amount of attention from all manufacturers of incandescent lamps. The company are now making arrangements for a factory for the manufacture of these pumps.

Mr. L. H. Rogers, New England agent of the Brush Electric Company, has sold a 30-light Brush dynamo with lamps of 2,000 c. p. to the Burlington Gas Light Company, of Burlington, Vt. There are now eight Brush dynamos in all in this station.

WESTERN TRADE NOTES.

Shay, Stephens & Co., 134 Van Buren street, manufacturers of insulators and battery jars, are doing a large amount of business with the electrical trade. Their insulators are of a special grade of glass and give a very high insulation and are also remarkably durable. They propose to push this branch of their business with the utmost vigor, which will be easy we opine from the fine class of goods which they are making and which have given such excellent satisfaction heretofore.

Noyes Bros., 85 Fifth avenue, Chicago, are turning out some very handsome electroliers which show remarkable taste and beauty in their designing. Their fixtures are in large demand and have been used in a large number of plants.

Mr. W. H. McKinlock, president of the Central Electric Co., has gone East on a short business trip. He will not return without numerous orders for his company's specialties which are now so well known in all parts of the country.

Mr P. C. Burns, the treasurer of the Findlay Glass and Carbon Co., of St. Louis, was in town last week looking after the interests of the company. He made his headquarters at Mr. C. H. Cone's office on Adams street, the well-known representative of the company in this city.

The Knapp Electrical Works, 54 Franklin street, were visited last week by fire which occured about 2 o'clock in the early morning of the 13th and burned out the second floor of their fine building. The machinery located there was badly damaged. It is understood that the damage is fully covered by insurance. The extent of the loss is not yet known.

Mr. George Kelly, 211 Randolph street, manufacturer of the World's Fair wire link belt, which is meeting with good success, and is especially adapted for work in very hot places, has moved his offices to more commodious quarters on the second floor. He also makes a specialty of wire link matting, and his floor is carpeted with handsome and fanciful designs in mats. These mats are remarkable for their durability.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager.

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada. - - - - - -	per annum,	**$3.00**
Four or more Copies, in Clubs (each) - -	"	**2.50**
Great Britain and other Foreign Countries within the Postal Union	"	**4.00**
Single Copies, - - - - - - - - - - - -		**.10**

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, MAY 28, 1890. No. 108

Study science with earnestness—search into nature—elicit the truth—reason on it, and reject all which will not stand the closest investigation.—Faraday.

THE BOSTON MEETING OF THE ELECTRICAL ENGINEERS.

SINCE its inaugural out of town meeting, held in Philadelphia in 1884, the American Institute of Electrical Engineers has held its sessions in this city; but in recognition of the national character of the organization, the managers very wisely determined to inaugurate the seventh year's work of the Institute by following the practice of the other representative engineering societies of the country and arranging a meeting away from home. The large New England membership of the Institute made the selection of Boston for the meeting place an eminently proper one, and the success which attended the meeting is evidence of the felicity of the choice. In regard both to the excellence of the papers presented and the attendance, the Boston meeting compares favorably with any ever held by the Institute. But when to this we add the opportunities offered by the second day devoted to excursions, following after the other courtesies extended, we have no hesitation in saying that the Boston meeting was the most successful of any thus far to the credit of the Institute. The members of the electrical fraternity of Boston vied with one another in their attempts to make the visitors feel at home. The Boston Electric Club is especially entitled to the kind remembrance of the visiting members and its hospitable entertainment was one of the most pleasant features of the meeting. The West End Street Railway Co. and the Thomson-Houston Electric Co. also deserve the warmest thanks of the Institute for the opportunities offered for the inspection of the largest electric railway system in the world and one of the largest electrical manufacturing establishments in existence. When we add to this the courtesies extended by the Massachusetts Institute of Technology, it will be admitted that the Institute's choice of Boston was no mistake. Now that the practice of holding migratory meetings has been so happily tried again, it is to be hoped and expected that they will be continued at stated intervals, so that as many of the members as possible may be brought together to discuss plans and exchange experiences, and make new acquaintanceships.

STEAM AND ELECTRICITY ON RAILROADS.

Now that the economy of electric street railways may be said to be definitely settled, the electrical engineer already looks forward to the time when he will be called upon to attack the problem of converting our great trunk railways into electric transportation lines. This consummation has indeed long been a favorite theme for speculation, and though its accomplishment has in a general way been admitted to be possible, it was obvious to the engineer that the conditions of the competition, as it were, are quite different from those which the electric motor encountered in its contest against the horse or mule. In the latter case the result was but a repetition of the defeat of animal power by specially designed machinery with steam as the source of power. But when we come to consider the case of the supplanting of the independent steam locomotive by electricity we encounter the change from one type of steam engine to another, but with the addition of intermediary conversions of power into current and vice versa. Evidently then these conditions are quite different from those which electricity has already successfully overcome, and the recognition of this fact will go far towards the prevention of mistakes which are the result of enthusiasm unchecked by the sober contemplation of the conditions involved. The exact nature of the conditions, though hinted at in a general way, had not up to the present time been reduced to that definiteness which would entitle them to be considered as engineering data, and it is therefore a matter for congratulation that to the engineering profession at large a thorough discussion of this subject is made accessible by one whose previous training and work in this field at once gives his results the stamp of reliability as based on present practice. We refer to the admirable paper presented by Mr. O. T. Crosby before the American Institute of Electrical Engineers, in Boston, in which the subject under discussion is treated in its various practical bearings. The all-important question of the possibility of taking off the current from the conductors at high speeds having been successfully settled, Mr. Crosby enters into the discussion of the main questions as to the relative cost of power and operating expenses, generally, under various assumed conditions of practice, in which some very interesting relations are brought out as to the cost of power, in which, as was to be expected, the efficiency of the electric system plays a prominent part. The conclusions at which Mr. Crosby arrives are of the most encouraging nature and would seem to show that there is as great a future for the electric locomotive on the trunk line railway as there is on the street railway. With the experience gained in the latter work, that of the heavier, to come, will be greatly facilitated, and the attachment of the armature directly to the axle, which seems imperative for economy, will at once remove a fruitful source of trouble. Looked at it in its entirety, there appears to be nothing involved in the problem of general railway transportation by electricity which cannot be successfully met and solved, in the light of past experience, and success will therefore depend only on the application of correct engineering and right economic principles such as those so graphically brought out by Mr. Crosby.

ARC LIGHT CARBON TESTS.

More than ten years have now elapsed since arc lighting took its place among the recognized modern industries, but the changes and improvements which it has undergone have been few as compared with those in the incandescent lamp industry. The fact is apparent, however, that arc lighting is again attracting some of the attention which it formerly engaged almost exclusively. We have but recently had occasion to refer to a striking example of modern arc dynamo design, and are now reminded of the good work that can still be profitably bestowed on that most important element of an arc light system, the carbon pencil. The full importance of this item is aptly shown in the admirable Institute paper of Mr. L. B. Marks. Treating the subject from every standpoint involving economy in practical operation, he has shown in what manner and to what extent the character of the carbon, and especially its method of manufacture, influences its life and efficiency. It would lead us too far to enter into a detailed enumeration of the many points brought out by Mr. Marks, but we fancy that every arc light station superintendent will be stimulated to undertake for himself the determination of the carbon best suited for his circuits. Such a determination in one notable instance cited, resulted in the saving of considerable power and money. While the tests of Mr. Marks seem to fix very clearly the relative positions as to economy under varying conditions of use of the molded and forced carbons as made at the present day, it will probably be some time before the facts brought out will become generally recognized and action be based thereon. It is to be regretted that fuller details as to the exact ingredients of the carbons tested were not forthcoming. This, it seems probable, would have shed additional light on the differences noticed, both in quality, as regards resistance and texture, and in the action of the arc. This lack of information, however, was evidently not due to any oversight of the author, but must be assigned to the natural unwillingness of manufacturers to divulge what may be regarded as valuable trade secrets. Considering the fact, however, that the largest part of the carbons produced in this country at the present time are made from petroleum coke or some residue of petroleum distillation combined with some cementing material, the results obtained may probably be taken as due to carbons of fairly uniform composition. A survey of the literature on this subject stamps Mr. Marks' paper as one of originality and well directed research, which cannot fail to have its effect on this important branch of the arc lighting industry.

THE GLUE POT RISK.

In a paper read before the North Carolina State Firemen's Association last week, Mr. A. R. Foote took occasion to give that body some useful elementary information in a popular form as to the nature of electricity and of the dangers to firemen from electric light wires in buildings. The opportunity was a good one to clear electricity from the obloquy heaped upon it by a sensational press and by interested persons, and Mr. Foote in his wonted neat and epigrammatic manner brushed away the misstatements and misconceptions that have been so readily circulated or accepted.

A week or two ago in this city, for example, a committee of the National Board of Underwriters undertook to present as authentic a number of figures on the origin of fires, and went so far as to assert that "electricity was a most prolific source of danger, and its introduction has cost the insurance companies more than any method of lighting heretofore in use."

This report has since been scattered broadcast accompanied by proof sheets of fire tables, including a highly colored pyramid whose object is to present graphically the dangers of electric lighting. Mr. Foote analyzes the figures and shows that one single fire due to a glue pot did more damage than all that were attributed to electricity, even admitting that the charges against the wires were all well founded. In other words, and stated plainly, the assertions made by the committee were quite without foundation and the gaudy pyramid was a bald piece of deception.

The figures referred to by Mr. Foote will be found in the paper read by Mr. S. E. Barton last week in Boston at the dinner given by the Electric Club to the American Institute of Electrical Engineers. As Mr. Barton shows, the statement made by the committee in question, which by the way, seems to have consisted of one man, was a deliberate misrepresentation. His characterization of it that "it is shamefully unfair because it is untrue," stamps it as it deserves; and his careful review of figures from the same source proves that electricity instead of being the worst, is the best risk element that the underwriters have to deal with. Why cannot we be entertained with some breezy newspaper talk about the "deadly glue pot," if only for a change?

Electric Lighting In The Tropics.

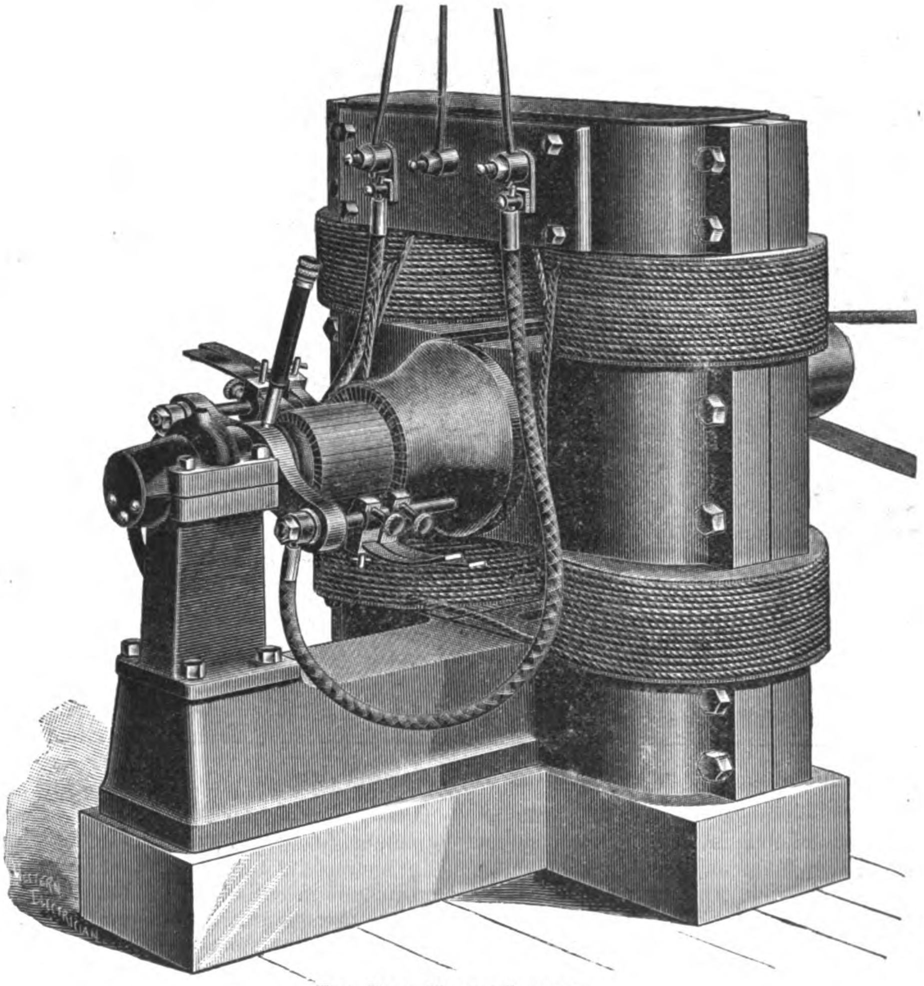
The paper on the above topic, read by Mr. W. H. Fleming before the American Institute of Electrical Engineers, gave in a chatty form no small amount of hard won experience.

They who have been engaged, like Mr. Fleming, in the tropics, know how difficult it is to keep a mechanical or electrical plant up to the right point of efficiency. One of the troubles is the securing of trustworthy help, and perhaps not the least among the others is that of fighting off the lassitude caused by the everlasting heat, which tempts to the habit of letting things go their own way. Still the rewards of electrical work in the tropics should not be small. The light is peculiarly adapted to hot climates and fair prices can generally be obtained. We believe that in the near future the electric motor will also come extensively into demand there, for stationary power purposes and for the operation of street railways.

THE BAIN MOTOR-DYNAMO.

Mr. Foree Bain, of Chicago, has recently designed and put on the market the motor-dynamo which we illustrate herewith. The cut is made from a 7 h. p. motor recently installed in the water-house of the Chicago Paper Co. The motor is used to operate a large freight elevator and a paper cutting machine, and it should be entirely satisfactory to the purchasers, a recent test showing, it is said, an efficiency of 95¼ per cent. The field magnets consist of two shafts of Norway annealed iron, one on either side of the armature, equal in length to the total height of the motor. They are clamped at either end by the double yoke pieces and midway between by very heavy pole pieces. This secures a maximum contact between the pieces; the field is of the "consequent pole" type, with two magnetic circuits.

The pole pieces are of equal size and weight, and consequently of equal magnetic density; therefore, the armature is not pulled harder against one side of the bearing than another, but it "floats" in a field in which the magnetic lines are equal and properly distributed. The double magnetic circuits are extremely short. The coils are wound on spools and slipped over the cores. The spools are only three inches long on this size of motor. There is absolutely no loss of magnetism due to false poles, usually produced by bad contacts in field magnet joints. The bearings are self-oiling.



THE BAIN MOTOR-DYNAMO.

The armature produces 1.4 volts per foot of active wire, with inductor velocity of 48 feet per second. The field is maintained with less than one-half an ampere, or 1¾ per cent. of the total current, and a density of about 600 amperes per square inch. The conductors on the armature are figured at a density of 2,700 amperes per square inch. The field resistance is nearly 1,300 times higher resistance than the armature. The motor runs quietly and very near constant speed with variable load.

Mr. Bain calls this type of machine his "motor-dynamo," not that it is a separate motor and dynamo combined in one machine, but that it may be used as either a motor or a dynamo. His machines show equal efficiency when they are used as dynamos. He builds this type of machine in sizes from 5 to 100 horse-power. The larger sizes have a peculiar compound, one of his late inventions, which is not yet quite ready for introduction.

THE PALMER HOUSE STORAGE BATTERY PLANT.

We are indebted to Mr. E. V. Baillard, electrician for the Electrical Accumulator Co., of this city, for some very interesting details of the storage battery plant recently placed by their Western agent, Mr. W. Hood, in the well-known Palmer House, in Chicago.

The plant comprises 120 cells of the 15 h. type, arranged in 3 series of 40 cells each. These give a capacity of 1,000 ampere hours at a normal rate of discharge of about 100 amperes. The cells are charged from a United States (Weston) dynamo, giving 225 amperes at 70 volts, driven by a Westinghouse engine. This plant takes care of 385 lights, scattered about in various places in the hotel, on a number of circuits.

The dynamo is started at noon time and run to supply lights and charge the battery at the same time. When the load of lamps is equal to the capacity of the dynamo, the battery is cut out. As the load increases and becomes more than the capacity of the dynamo, the battery discharges and helps the dynamo, acting as an auxiliary. When the load decreases towards the latter part of the evening to less than the capacity of the dynamo, the battery is charged with the surplus. At midnight the dynamo is shut down, and the battery substituted to take care of the lights until noon next day. In this manner the lights are available for 24 hours, while the dynamo is run only 12 hours. The capacity of the dynamo is, as will be seen, increased to an available output of 325 amperes, or 100 more than its actual output when running. By putting the current not needed for the lights in the battery, the dynamo and engine can be worked at a point near their maximum output, thereby obtaining the highest efficiency.

The switchboard, which is very handy and convenient, is made up mainly of round and flat copper bars taped and painted with P. & B. compound, all held in place by porcelain insulators. Each cell is placed on a tray supported on porcelain insulators and carried by battery stands of special construction, enabling each and every cell to be frequently and easily inspected. Hence the insulation of the plant is very high.

All the circuits, the dynamos and batteries, terminate at the switchboard, where any combination can be made without budging an inch. A voltmeter is arranged so that the pressure can be measured between the various points of the system, also the E. M. F. of the battery. Each series of accumulators is provided with a switch by which the number of cells in series and the E. M. F. can be adjusted as desired; also a variable resistance so that the current can be varied as desired. An ammeter and a two-way switch are also in each series, thus making each series independent of the other. The dynamo has an ammeter and a two-way switch, which enables running the dynamo direct, or to charge battery and supply lights. There is a pressure equalizer in the main lamp circuit. Between the dynamo and battery is an automatic break-switch which breaks current from the dynamo whenever, through any accident, the dynamo is incapacitated.

All these switches can be quickly and easily handled, and any combination made without in any way interfering with the steadiness of continuity of the lights.

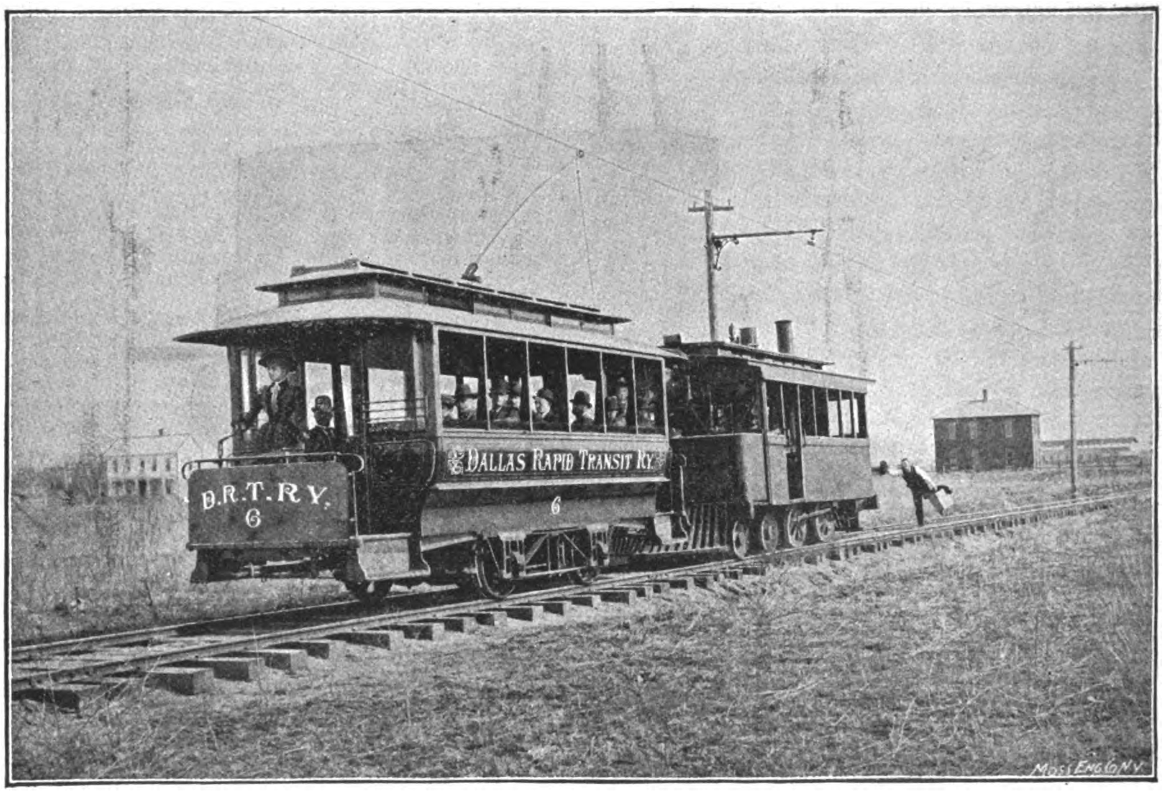
It is fairly to be expected that we shall see many such plants as this in the near future, as they allow a dynamo to be run at its full capacity and highest efficiency, and enable the owner of a building or the superintendent of a moderate sized station to bridge over the hours when the lightness of load would forbid operation at all, or when the plant would be taxed beyond its actual ability.

ELECTRICITY SUPPLANTING STEAM ON THE DALLAS, TEX., RAPID TRANSIT RAILWAY.

The subject of electric railroading has received a great deal of attention in the southwest, and that part of the country is fully awake to the advantages of electric power for car propulsion. The State of Texas has now two electric railways in operation on the Sprague electric system, and others are in course of construction. One of the roads in operation is the Dallas Rapid Transit Railway, a view of which is shown on this page. The motive power for operating the cars on this railway was formerly furnished by a steam dummy, which has now been abandoned for the more modern power.

Our view shows one of the electric cars drawing the old steam dummy. The engraving was made from an instantaneous photograph, and shows the ex-engineer of the steam engine trying in vain to catch the train, which is going so rapidly that he is left behind. An interesting circumstance in connection with this view which shows very clearly the easy manipulation of the electric car, is the fact that the motor car is being operated by a young lady who is in charge of the controlling switch, while another young lady is acting as conductor. By way of comparison it might be mentioned that the steam dummy required an engineer and fireman to run it besides a train conductor on the train.

The electric road has proved very popular in Dallas, and has carried a large number of passengers since its installation. The method of overhead construction used is the single bracket, as shown in the illustration.



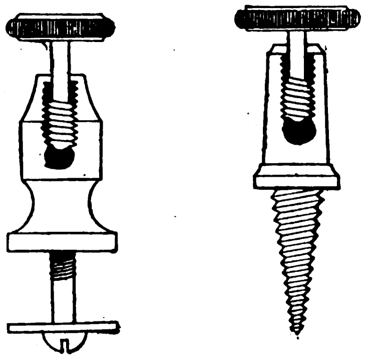
A Trip on the Dallas, Tex., Rapid Transit Railway.

The district messenger boys of New York city have amused themselves during the past week by indulging in a strike, which is said to have come to an early end, but of which reports are still current.

THE DELANY SECURITY BINDING POST.

We illustrate herewith another of the many ingenious novelties that Mr. P. B. Delany amuses himself with producing at his leisure "'tween whiles." Mr. Delany has found occupation for his inventive genius not only in broad methods of telegraph operation but in the countless minor details of familiar apparatus and appliances that are in use every day; and it is to be hoped that he may go on seeking for improvements of this kind.

The article in question, just brought out by The E. S. Greeley & Co., of this city, who have the exclusive rights of manufacture and sale, is the Delany security binding post. It is safe to say that imperfect binding posts have offered as much resistance to the current and as many obstacles to the extended use of electrical appliances as any other single imperfect detail that could be named. The screws have just as great a knack of disappearing as a man's shirt stud has when he is in a hurry to dress. They work loose, jam tight, get lost in transit, shake out, invite the attention of the mischievous; and are often not less a means of torture to the working electrician than the binding post of old was to the unrecanting saints on Scottish sands, or the thumb screws once were to the reserved people who declined to be interviewed.



The Delany Security Binding Post.

A great feature with the new binding post of Mr. Delany is that the screw cannot come out, simply backing far enough to clear the hole, but no further. The thread of the screw is on a shoulder larger than the stem, and as the neck of the cup is turned over tight up to the stem, the screw part cannot pass. The operation is plain and perfect. The binding posts are made in all sizes and shapes. They look just like the ordinary binding posts. It will be strange, indeed, if they do not come into general use, not only for telegraph and telephone instruments and switches, but for all kinds of electrical machinery, including dynamos and electric motors. One great advantage of the new post is that when wiring has to be done in dark and difficult places it can be known with certainty that the wire hole is clear when the screw is withdrawn to the limit. They who have juggled painfully with a set of cells in the recesses of a dark sub-basement or have spent several weary hours in a small cupboard under the office wash bowl, with a one-inch candle as their only companion and consolation, will hail Mr. Delany as a benefactor.

KEMMLER-CASE DELAYS.

It is stated that when the habeas corpus proceedings brought to delay the execution of Kemmler by electricity reach an end (the one still to be acted on raises the question whether the Warden of the prison or the Sheriff of Erie County must be the executioner), the lawyers interested will ask for an injunction on the ground that the particular dynamo that has been set up in Auburn State Prison was sold with a proviso that it was to be used in some other county.

ANNUAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual meeting of the institute was held at the house of the American Society of Civil Engineers, in this city, on May 20, at 8 p. m., with Vice-President F. R. Upton in the chair. There was a large attendance.

Secretary Pope presented his report showing a prosperous state of affairs. The Institute has now made arrangements to occupy quarters jointly with the Mechanical Engineers in the Academy of Medicine building at 12, West Thirty First street, this city, the Mechanical Engineers having bought that house. There it will enjoy large offices, a fine auditorium and ample space for library purposes. The membership now is 427, comprising 2 honorary, 145 members, and 280 associate members. The secretary's balance showed total receipts of $5,846, and a surplus of $64, the actual balance in the treasury, however, being $249. The report of the treasurer confirmed these figures, showing also $350 on hand for building fund.

The chair then appointed Messrs. T. C. Martin, C. G. Curtis and N. Tesla as a nominating committee, to name officers to be elected for 1890-1. Mr. G. Wilkes then read a paper on "Electricity in the Navy," printed elsewhere in this issue.

The nominating committee then reported that they had received a nomination of F. R. Upton as president, but that Mr. Upton absolutely refused to allow the use of his name. They submitted the following "ticket:" For president: Prof. W. A. Anthony; for vice-presidents, Prof. F. B. Crocker, J. Wetzler and F. J. Sprague for managers, H. Ward Leonard, J. C. Chamberlain. H. A. Foster. P. B. Delany; for treasurer, G. M. Phelps; for secretary, R. W. Pope; These were unanimously elected, making the full Council for 1890 as follows; *President*, Prof. W. A. Anthony; *Vice-Presidents*, Edward Weston, Prof. Edward L. Nichols, Prof. F. B. Crocker, J. Wetzler and F. J. Sprague; *Managers*, Charles Cuttriss, George B. Prescott, Jr., Thomas D. Lockwood, William Maver, Jr., Dr. F. Benedict Herzog, Prof. Wm. E. Geyer, H. C. Townsend, H. Ward Leonard, J. C. Chamberlain, H. A. Foster and P. B. Delany; *Treasurer*, George M. Phelps; *Secretary*, Ralph W. Pope. This leaves a vice-presidency and a managership to be filled by council, the vacancies being caused by the death of Major O. E. Michaelis and the resignation of Henry Van Hoevenbergh.

After a discussion on the advisability of having the elections take place wherever the general meeting might be held, and not necessarily, as now, in New York, the meeting adjourned.

The following is a list of members and guests who attended the Boston Sessions of the American Institute of Electrical Engineers, May 21st, 1890.

W. A. Anthony, Manchester, Ct.
G. L. Austen, Boston, Mass.
S. E. Barton, Boston.
R. N. Bayles, New York.
Dr. Louis Bell, New York.
W. H. Blood, Jr., Lynn, Mass.
Geo. W. Blodgett, Auburndale, Mass.
Charles L. Bradley, Yonkers, N. Y.
Edw. C. Caldwell, Boston, Mass.
Geo. F. Curtiss, Lynn, Mass.
John S. Cobb, New York City.
Henry B. Cram, Boston, Mass.
Francis B. Crocker, New York City.
O. T. Crosby, New York.
Chas. R. Cross. Boston, Mass.
A. Floyd Delafield, Noroton, Conn.
A. A. Dion. Moncton, N. B.
A. E. Dolbear, College Hill, Mass.
L. S. Dumoulin, Boston. Mass.
Richard N. Dyer, New York City.
Herbert H. Eustis. Boston, Mass.
M. J. Francisco, Rutland, Vt.
George G. Grower, Ansonia, Conn.
Caryl D. Haskins, Lynn, Mass.
Geo. A. Hamilton, New York City.
Edwin H. Hall, Cambridge, Mass.
Wm. J. Hammer, Newark, N. J.
J. W. Howell, Newark, N. J.
W. L. Hooper, College Hill, Mass.
D. C. Jackson, New York City.
F. E. Jackson, Newark, N. J.
S. Katogi, Japan.
A. A. Knudson, New York, N. Y.
H. Lemp, Jr., Lynn, Mass.
Geo. W. Mansfield, Boston.
Louis B. Marks, Ithaca, N. Y.
J. A. Miller, Providence, R. I.
E. W. Mix, Lynn, Mass.
Edw. L. Nichols, Ithaca, N. Y.
C. Wellman Parks, Troy, N. Y.
F. A. C. Perrine, Trenton, N. J.
Geo. M. Phelps, New York City.

Ralph W. Pope, Elizabeth, N. J.
F. L. Pope, Elizabeth, N. J.
Robert J. Pratt, Greenbush, N. Y.
Geo. B. Prescott, Jr., New York City.
Michael I. Pupin, New York.
E. W. Rice, Jr., Lynn, Mass.
L. H. Rogers, Boston, Mass.
A. L. Rohrer, Lynn, Mass
R. F. Ross, Boston, Mass.
R. W. Ryan, New York City.
W. H. Sawyer, Providence, R. I.
A. C. Shaw.
C. J. Spike, Halifax, N. S.
Kenneth R. Stewart, London, Eng.
O. K. Stuart, Boston, Mass.
John Tregoning, Lynn, Mass.
Elihu Thomson, Swampscott, Mass.
Wm. S. Turner, New York City.
Joseph Wetzler, New York City.
J. P. Wintringham, Brooklyn, N. Y.
Charles Wirt, New York.
Alex. P. Wright, Boston Mass.

The meeting of the Institute was called to order on Wednesday morning in one of the large lecture halls of the Massachusetts Institute of Technology by the Secretary, Mr. R. W. Pope, who introduced Gen. Francis A. Walker, President of the Institute, who, with a few well chosen remarks, welcomed the American Institute of Electrical Engineers to Boston and to the Massachusetts Institute of Technology. He referred to the work which the Institute had been doing in the past and was now engaged in training young men for the profession of electrical engineering, and referred to the fact that the positions already occupied by many of them showed the advantages which a thorough training gives to those who are about to undertake the battle of the world.

The chair was then taken by the retiring President, Professor Elihu Thomson, amid great applause.

DISCUSSION.

Morning Session.—In the discussion of Mr. Fleming's paper on "Electric Lighting in the Tropics," Prof. Elihu Thomson drew attention to the fact that American electrical engineers whose work has been almost entirely confined to temperate climates, have no conception of the effect upon all kinds of electrical apparatus exposed to atmospheric influences in the tropics. He remarked that frequently instances had come under his observation in which well insulated overhead lines in tropical countries had been attacked by the salt spray together with the rotting vegetation, which had entirely destroyed the insulation and converted the copper into a green mass of very little conductivity. It therefore became necessary to take extreme precautions in protecting all exposed work in the best manner possible.

In referring to the results contained in the paper by Mr. L. B. Marks on "Arc Light Carbons," Mr. G. W. Blodgett disagreed with the author and stated, as the result of his experience, that soft carbons were better than hard ones for high tension currents.

Prof. Thomson also referred to the results of a large number of experiments made by him on the subject in determining the best type of carbon to use, and agreed in substance with the results obtained by Mr. Marks. Prof. Thomson pointed out that hissing was mostly met with in carbons having a coarse grain and explained this as due to the vaporization of the positive pole, which becomes so vigorous that the carbon particles explode; but if sufficient time to vaporize is afforded and with small carbon particles this does not take place and no hissing is observed. He instanced an analogy in citing the sublimation of sal ammoniac, which, if carried on slowly, is effected without violent disturbance, but on the contrary may result explosively if carried on too fast. He also cited the case of the Carré carbons, which were of an exceedingly hard nature, but of very uniform composition, and which, while burning, emitted a musical, whistling note due to the uniform explosions which took place. The results of experiments made by Prof. Thomson in 1881 and 1882, seemed to point to the fact that the forced carbon was unsatisfactory at that time, and on examining both kinds the difference in structure pointed out by Mr. Marks was noted; the forced carbon had a glistening aspect from the side and a dull one when looked at from the end, while the molded carbon showed the reverse. His experience had proved to him conclusively that the best form of carbon to-day is the molded carbon, confirming the results of his early experiments. Prof. Thomson pointed out how a long arc blunts the end of the crater and causes the arc to flame and run up the side. This he considered due to the decreased counter electromotive force under those circumstances and he pointed out some of the methods which had been proposed for avoiding the disturbances noted. Among others, he referred to the use of one negative and a series of positive carbons, one arrangement of this kind being due to Dr. Fleming. Prof. Thomson pointed to the special difficulty of making arc lamps of high candle-power, such as are used in arc projectors, operate silently. These lamps give warning when they are going to hiss. This generally consists in the negative carbon sending out striæ of various colors, and in one instance by the use of 150 amperes in an arc having a crater $\frac{9}{16}$ inch in diameter, these striæ were shot out for a distance of eight inches. The introduction of the soft-cored carbons which confined the arc to the centre, Prof. Thomson considered to be a great improvement.

Mr. L. B. Marks referred to the fact that an attempt had been made by him to confine the arc to the centre of the carbon by a magnetic coil, but he had not carried out his experiments to any great extent. Prof. Thomson remarked that he had some time ago also worked in that direction.

Mr. O. T. Crosby drew attention to the fact that the results obtained by Mr. Marks were based on runs of but one hour in each case and suggested that longer runs might have the effect of modifying some of the results obtained. In reply, Prof. Thomson remarked that in his opinion it would be safe to predict the results with accuracy on one hour runs, provided, that the carbons operated upon all came from the same batch; where this was not the case, however, the results obtained might vary. Mr. Marks corroborated the latter statement and showed that one set of carbons obtained by him and subjected to mechanical tests, broke with a strain of 43 pounds, while another required 48 pounds breaking strain.

Prof. Anthony referred to the personal equation in the photometric test in arc lighting and pointed out that due allowance ought to be made for this in estimating illuminating properties of an arc lamp. Mr. Frank L. Pope inquired whether Mr. Marks had determined or taken into consideration, the nature of the raw materials upon which the carbons operated upon by him had been made. In answer, Mr. Marks stated that the companies manufacturing carbons were generally very reticent. One of them, however, he stated, made their carbons of the product of the second distillation of petroleum, to which is added ¼ its weight of pitch; in another case ⅓ its weight of pitch was added.

Prof. Thomson referred to the almost total abandonment of gas retort carbon as a material for arc carbons. He pointed out that it was hard to grind and contained impurities such as iron, ash, etc., which resulted in an unsteady arc, and which it was practically impossible to eliminate. He also remarked that they had completely abandoned the use of forced carbons for high tension arc lamps.

Mr. Frank L. Pope suggested that some one ought to do for the battery carbons what Mr. Marks had done for arc light carbons and subject them to a thorough test in order to determine the relative value of the various types now made. He pointed out that a carbon made of sea weed had shown very good results for battery purposes, and Prof. Thomson remarked that a similar carbon had been submitted to him for arc light purposes, but that its nature was not such as to warrant its adoption for such purposes.

In the discussion of Mr. Parshall's paper on the "Magnetic Data of the Sprague Street Car Motor," Dr. Louis Bell gave the results of some tests made by him on an old type Sprague street car motor, in which he showed that the ratio of magnetic strength of field to armature was as 1 to 1.65, but he pointed out the fact that this ratio was not constant and was liable to vary, particularly when, in consequence of repairs, the motor was taken apart and put together again, owing to the fact that the joints were not so carefully made as when the motor was first put together.

Afternoon Session.—The afternoon session was opened with the new president, Prof. W. A. Anthony in the chair, who thanked the Institute for the honor conferred upon him and expressed the hope that it would continue to prosper under his presidency as it had so signally during that of his predecessor.

The first paper read was that of Mr. Oscar T. Crosby on "The Limitations of Steam and Electric Transportation." In the discussion which followed, Dr. Louis Bell remarked that in the carrying out of long distance high speed railway traffic, nearly all the difficulties met with in street car work disappeared. Principal among these was the avoidance of all gearing by the direct application of the armature to the motor axle and the ease with which the motor could be protected from dirt and dust, etc.

In discussing the paper of Dr. Michael I. Pupin, on "The Practical Aspects of Alternate Current Theory," Mr. Crosby inquired whether in the experience of those practically engaged in such work more difficulty had been met in designing alternating current machines than with the continuous. Prof. Thomson in reply stated that in his experience such was not the case and that the difficulties met with in the one case were, as a rule, absent in the other, so that it might be said that no greater difficulties are met with in the alternating current machines than in those designed for continuous current. Further discussion of this paper was postponed for lack of time.

After reading his paper on "Automatic Electric Welding Machines," Mr. Hermann Lemp, Jr., gave an experimental demonstration with the machines which had been placed on the platform. Welds between various metals were made, the time consumed in each being but a small fraction of a minute and the tests of the welds showed them to be perfect. There was also shown an ingenious device for stripping the wire of the burr made by the weld, so that the diameter was reduced to the same as that of the original wire and leaving the surface smooth for a continuous winding. Several of the members present, after witnessing the operation, were able to make perfect welds, owing to the remarkable simplicity and automatic qualities of the machine.

Between the morning and afternoon sessions a group picture of the members of the Institute was taken on the steps of the Brunswick House opposite the Institute. Invitations were read by the Secretary from the Boston Society of Civil Engineers inviting the members to inspect various points of interest about the city. The Union Car Company also invited the members to an inspection of their storage car road operating between Beverly and Danvers. On Thursday morning the members of the Institute assembled at the Massachusetts Institute of Technology at nine o'clock and inspected the electrical and physical laboratories, all of which were thrown open. The facilities offered for thorough work in the electrical laboratories especially were evident. A complete electrical plant, embracing various types of dynamos, both continuous and alternating, motors, converters, etc., is provided, together with a complete installation of measuring instruments for testing, together with a photometric room.

After devoting an hour to the laboratories, the members entered carriages which had been provided by the West End Railway Co., of Boston, and were driven to the large power station now in course of erection. The work has thus far progressed only to the erection of the foundations, which alone are well worthy of a visit. The station is designed for 18,000 horse-power and must undoubtedly be considered one of the finest engineering enterprises undertaken in this country. The present temporary station, equipped for 1,500 horse-power, is itself a model in its way, and thorough arrangements for controlling and supervising circuits and apparatus are everywhere manifest. The members were conducted about by Mr. Dumoulin, the assistant engineer of the company, and Mr. Pearson, the chief engineer of the company. Numerous detail drawings which were explained to the members showed the plan which it is proposed to carry out in the construction of the station. The mechanical engineer in charge of construction is Mr. C. Hirt. From this point the members again entered carriages and were driven to Park Square, where a number of special cars in waiting took them over the Chestnut Hill Branch of the Boston electric railway system. This branch, covering a distance of between four and five miles, ends at the Chestnut Hill Reservoir and passes through one of the most fashionable suburbs of Boston. The road is everywhere built with the greatest care and for the largest part of the way runs in the centre of a magnificent boulevard. For a large part of the way the tracks run through a green sward, so that at a distance the rails are almost completely hidden from view. The quality of the work which has been done here can best be estimated by the fact that the speed on this part of the road, being outside of the city limits, frequently reaches 15 and 18 miles an hour. The road has been largely instrumental in building up this suburb, and the large number of houses noticed in the course of erection gives unmistakable evidence of the value which electric railroads add to suburban property. Upon the return of the members they were entertained at luncheon by the West End Company at the Parker House, where a vote of thanks was unanimously carried.

At two o'clock the members started on the journey to Lynn as the guests of the Thomson-Houston Company. On their arrival they were conveyed to the factories of the company and started on a tour of inspection of the shops in squads under the leadership of guides provided for that purpose. It would take many columns to describe the variety and interesting character of the work being carried on here, and we must content ourselves with merely stating that hardly a nook or cranny was left unvisited by the visitors. While the various processes of dynamo, motor and lamp construction were greatly admired and enjoyed by the visitors, the operations going on in the welding factory elicited unbounded enthusiasm. In order to show the visitors a large variety of work and the ease with which it could be accomplished, machines welding metals from the smallest sized wire to bars an inch and a half in diameter, pipes, steel cables, etc., were exhibited to them. As one of the members upon leaving remarked to Prof. Thomson (who accompanied the party throughout the day), the visit to the factories was a liberal education in itself. Considerable interest was also shown in the new wattmeter of Prof. Thomson, which is designed to operate equally well on both continuous and alternating circuits. After a thorough inspection, the members departed, with cheers for Prof. Thomson and the Thomson-Houston Company.

The Boston meeting will long be remembered as one of the most interesting which has thus far been held by the Institute, and the success attained was largely due to the untiring efforts and courtesy of the members of the Boston Electric Club, the West End Railroad and the Thomson-Houston Electric Company, whose only aim seemed to be to make the visiting members thoroughly at home, in which effort they may be said to have succeeded in the most eminent degree.

THE RELATION BETWEEN FIRE INSURANCE AND ELECTRIC INTERESTS FROM THE UNDERWRITERS' STANDPOINT.[1]

BY S. E. BARTON.

At the annual meeting of the National Board of Fire Underwriters in New York on the 8th of this month, several very interesting papers upon important topics affecting the welfare or ill-fare of the business were presented.

An extract from the newspaper reports of that meeting reads as follows: "The most interesting report came from the committee on lighting and heating, read by Chairman John H. Washburn. 'The great problem before us to-day,' he said, 'is the management of the various systems of electric lighting, which is not the harmless thing we had imagined, but a most prolific source of danger. It has come to stay, however, and in time it will probably be as safe as any light in use.' With the report a graphic diagram was handed in, which showed that while electric wires and lights were responsible for losses of only $480,000 in 1886, the value of property injured by fire which could be traced to the same source in 1889 was $5,533,000."

Such a report coming from a body representing, as its name implies, the fire underwriters of the nation, conveys to the public the idea that "the relation between fire insurance and electric interests from the underwriters' standpoint" is a very gloomy one for the former.

I was sorry to see such a bald statement go forth without any explanation as to how it was arrived at, or what it indicated. If it was intended to indicate, as it certainly does to every person not acquainted with the facts, that the danger of fire from electrical causes had grown to be twelve times greater in 1889 than it was in 1886, it is shamefully unfair, because it is untrue.

As the figures given are identical with those contained in the "Chronicle Fire Tables," published by the Chronicle Company of New York, I presume they came from that publication, and therefore it is fair for me to draw from the same source to show how unfair the report really is.

Those tables show that in 1886 there were 29 fires from "electric wires and lights," causing a loss of $450,000; in 1887, 66 fires and $881,000 loss; in 1888, 91 fires with $1,587,000 loss; and in 1889, 74 fires with $5,533,000 loss. The yearly increase in the *number* of fires reported is nowhere near the percentage of increase in the use of electric lights and wires, and therefore the number of fires was not used to show the comparative hazard by years. It looked much more startling to use the amount of loss, and for that reason I presume it was used; I can see no other reason for using it. But where did the great increase in amount of loss come from? Why! from the Boston fire of last Thanksgiving day, which "everybody says was caused by the electric wires," but which *nobody* has proved. The fire marshal in his investigation exhausted his energies and all means at his disposal, and certainly the bulk of the testimony taken would naturally lean towards fixing it upon the electric wires. The Massachusetts Insurance Commissioner, in his 1889 report, just issued, says "the preponderance of the testimony seems in favor of the theory that it was caused by the electric wires;" therefore, in his opinion (which is good enough for me), it is a "theory" that confronts us and not a condition nor a fact. That loss amounted to about three millions and a half. It was injected into the destruction account of "electric wires and lights," making the account four times as large as in 1888, and yet, admitting the right to charge the fire to that account at all, it only increased the number of accidents by one. Supposing the fire had got still further beyond the control of the firemen, and had destroyed one hundred millions instead of three and a half, of course it would have proved (according to the logic of the report of the National Board) that electricity is twenty-two times as hazardous as the report makes it out to be.

The official return of the big fire at Lynn says it was caused "by a draft from an open door blowing the blaze from an oil stove down around the burner, causing the stove to explode." The loss by that fire was about four and one-half millions, and I presume it should be charged in equal proportion to open doors, drafts and oil stoves.

Two fires were reported in Massachusetts last year as caused by "reflected rays of the sun." If they had destroyed five and a half millions of property the combination of the sun and a reflecting surface might fairly be regarded as "a most prolific source of danger."

In the language of the report which I have referred to I am compelled to say that the committee that made it "is not the harmless thing we had imagined, but a most prolific source of" misrepresentation. Let me bore you with a few figures from the Massachusetts insurance report referred to, as to the causes of fires. They are the official returns from all the towns in the state, and cover the period of 1884 to 1889, inclusive.

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[1] A paper read at the dinner given by the Boston Electric Club to the American Institute of Electrical Engineers, May 21, 1890.

Broken and exploded kerosene oil lamps and lanterns:—	
Number of fires in 1884	136
Number of fires in 1889	217
Increase of 1889 over 1884, 59⅛ per cent.	
Explosions of gas:—	
Number of fires in 1884	4
Number of fires in 1889	8
Increase of 1889 over 1884, 100 per cent.	
Careless use of matches:—	
Number of fires in 1884	45
Number of fires in 1889	90
Increase of 1889 over 1884, 100 per cent.	
Children playing with matches:—	
Number of fires in 1884	78
Number of fires in 1889	116
Increase of 1889 over 1884, 49 per cent.	
Ignition of curtains and goods by gas and candles:—	
Number of fires in 1884	42
Number of fires in 1889	38
Decrease in 1889 from 1884, 10 per cent.:	

and this decrease is doubtless due to the fact that the incandescent lamp is rapidly replacing the gas jet and candle in windows and stores.

In 1884 "electric wires" caused 6 fires, and in 1889, 7; increase of 1889 over 1884, 16 per cent.

Total number of fires for the whole six years from each cause is as follows:

Broken and exploded lamps and lanterns	947
Explosions of gas	28
Ignition of curtains and goods by gas and candles	233
Careless use of matches	447
Children playing with matches	473
Electric wires	42

Besides these, during the same period, 25 fires came from gas and candles near wood-work, and 1884, 1885 and 1887 are not included, as they were not reported.

Lightning caused 208 fires; plumbers' pots, 27; thawing water pipes, 89; tramps, 54. There appear to be none charged to the much despised "tramp wire," unless he was the means of conducting the subtle fluid in some of the 42 cases against electric wires.

Cigar stubs in wooden spittoons caused 41 (1884 and 1885 not reported).

Smoking caused 233 fires, to say nothing of the 3,024 marked as "unknown," many of which were doubtless due to this "most prolific cause;" and yet "the management of the various systems" of smoking is not regarded as "the great problem" before the fire underwriter of to-day. He smokes day in and day out, perhaps causing his own share of fires, and yet he looks with increasing alarm upon a system of distributing light and power for the benefit of mankind, that has only been charged with causing 42 fires in Massachusetts in five years, as against 233 from smoking.

Let me step outside the confines of my little native state and give you a few comparative figures for the whole country, taken from the Chronicle Fire Tables for the year 1888. (I have used 1888 instead of 1889 because I happened to have them more handy.) I have selected a few classes of risks in which electric lights and wires are probably more generally used than in others.

In clothing stores the whole number of fires reported is, for the year, 1,072, 28 of which came from gas jets, 21 from lamps exploding, 9 from lamp accidents, 3 from gas explosions, 13 from matches—in all 74, as against 6 from electric lights and 9 from electric wires.

In country and general merchandise stores 4,847 fires are reported, of which 39 came from lamp explosions, 8 from lamp accidents, 3 from gas jets, 20 from matches—in all 70, as against 1 from electric wires.

In crockery and glassware stores 179 fires are reported, of which 8 came from lamp explosions, 7 from lamp accidents, 3 from gas jets, 4 from matches—in all 22, as against 1 from electric wires.

In dry goods stores 1,858 fires are reported, 123 of which came from gas jets, 34 from lamp explosions, 6 from lamp accidents, 7 from gas explosions, 19 from matches—in all 197, as against 10 from electric wires and 3 from electric lights.

In fancy goods stores 519 fires are reported, 28 of which came from lamp explosions, 7 from lamp accidents, 27 from gas jets, 9 from matches, 2 from candles—in all 73, as against 4 from electric wires.

In the United States in 1888 the whole number of fires from the above named causes is reported as follows: Lamp and lantern explosions, 528; lamp and lantern accidents, 190; gas jets, 179; gas explosions, 63; matches, 592—in all 1,552, as against 49 from electric lights and wires.

There were 53 from stationary engines and boilers, and that number, though small, can be reduced just as fast as the electric motor takes the place of the boiler and stationary engine.

In the matter of insurance upon electric generating stations, the "great problem" is practically settled; and it has been settled by the establishment of an Electric Mutual Insurance Company, organized for the prime purpose of improving and insuring such risks. There is no trouble whatever to-day in procuring ample insurance in the strongest of stock or mutual companies, provided the Electric Mutual carries a part of the risk; and I predict that within one year companies that have heretofore frowned upon an offer of insurance upon the best of such risks, or have charged excessive rates, will be competing for the business. The one truth contained in the extract of the National Board report, namely, that the "business has come to stay," together with the fact that the owners of stations are willing to take their own risks by insuring in a company of their own, has inspired many of the underwriters with courage who were previously possessed of fear and doubts.

Of the 31 fires that were reported in electric light stations in 1888, 11 were from exposure to other risks, 4 were from unknown causes, 5 were from causes not reported, 1 each from engine, furnace, spontaneous combustion, lightning and explosion, while 6 came from "electric wires;" showing that after all it is not the mysterious electric current nor the pranky wire that are responsible for the havoc, but that the ordinary causes that pertain to other risks, such as improper location, contiguous to bad neighbors, and carelessness of various kinds, are the chief sources of danger.

In seven years previous to and including 1888, 80 fires are reported in electric light stations, about 11 per year on the average.

On the whole, I don't know what the relation between the interests is, from the underwriter's standpoint. What are his views to-day may not be to-morrow. There is no hazard that underwriters, as a rule, have made so little effort to understand, and consequently they are too largely guided by the caprice of popular prejudices and beliefs, neglecting to carefully study their tables of experience and be guided by the logic of events. There is also no hazard around which they have ever thrown so many restrictions. Those of us who know what peculiar and improbable conditions must exist in order for the "electric wires" to cause fire, can only look on and hope. Enlightenment comes slowly but surely, and the day is not far distant when the large majority of fire underwriters, forgetting their present ideas, will say "I always maintained it was the safest kind of light and power." In the meantime the present rapid development will go on regardless of the underwriter's standpoint. A few years ago his favor or opposition meant easy or slow progress for the electrical pioneer, because the first question asked was, "how will your wires and lights affect my insurance?" But the business has "come to stay," and that question is less frequently asked.

The same difference however exists to-day that always did exist between good and poor installation, and therefore it should be the aim of the electrical men to seek the co-operation of the underwriters in securing the observance of safe fundamental rules.

ELECTRIC LIGHTING BY GAS COMPANIES.

The following table is a summary of the list of gas companies operating electric lights given in "Brown's Gas Directory for 1890." Compared with the figures of a year ago the showing is:

SYSTEM.	ARC.	INC.
Thomson-Houston	16,927	45,055
Brush	6,090	4,259
Westinghouse	321	49,967
Edison	....	13,858
American	1,537	175
United States	632	6,141
Schuyler	1,066	....
Ball	962	6
Western Electric	788	....
Fort Wayne	1,756	8,005
Van Depoele	450	....
Waterhouse	287	....
Heisler	....	3,815
Remington	129	....
Sperry	160	....
Excelsior	205	30
Hochhausen	70	....
Weston	138	....
Fuller	10	....
Reliance	30	....
National	....	1,000
Bernstein	....	215
Total	31,558	132,771

	1889.	1890.
Number of gas companies operating electric lights	266	304
Number of different electric light systems used	21	23
Number of arc lights operated	21,313	31,558
Number of incandescent lights operated	55,890	132,771

ELECTRIC LIGHTING IN THE TROPICS.[1]

BY WILFRID H. FLEMING.

ONE of the chief difficulties that an engineer experiences who is called upon to install a plant of any considerable size in tropical countries is the trouble of procuring any kind of skilled labor for this particular class of work. Another difficulty is that he is so far from his base of operations—the factory—which will often lead him to depend upon himself in overcoming obstacles that arise from time to time as the work progresses. Language and the heat, as well as fevers, are minor affairs.

Electric lighting has already gained many warm adherents both in the East and West Indies, more especially in the former where plants of considerable capacity have been in active operation for the past eight years. It is especially adapted for use in houses in warm climates, such as that of India, where the old-fashioned "punkah" is in daily and nightly use for cooling the rooms, accompanied with its attendant noise as the "punkah wallah," a servant, pulls it backward and forward causing the continual flickering of the lamps or gas. That system will, in time, I hope, give place to the noiseless motor fans and steady incandescents, thus enabling the Anglo-Indian to read and rest in comfort.

A central station plant that the writer was engaged upon lately in one of the chief cities of the West Indies, would compare favorably in size and equipment with one situated in a city of a corresponding number of inhabitants in the United States. Alternating current dynamo of a capacity of 4,500 16 c. p. lamps were employed for lighting the chief stores, theatres and private houses, and 600 arc lights of 1,200 c. p. each lighted up the main streets and parks.

It was at first intended to run a small plant in connection with the existing gas works, more as an experiment than with a view to actual financial success, but in the space of six months the station was more than trebled from its original capacity.

The people took to it from the start, paying cheerfully the prices that were demanded To an indolent race it was a great boon. Money to them, it would appear, was of less account than the trouble and work called upon to go around and light up the different oil and gas lamps, since all the lights were switched on the different circuits at sunset. In the tropics, as is well known, there is no twilight. Darkness comes on within 10 minutes of sundown and the whole plant practically goes into operation at once.

The construction work on this particular plant was necessarily somewhat slow, as men unaccustomed to erect a 30 or 45-foot pole took their time to do so, in which operation they received the appreciation of the usual army of idlers. Poles suitable for carrying a number of circuits had to be imported from the United States, as well as the ornamental wooden columns for supporting the lamps in the parks and public squares. Poles of native growth could not be found straight enough and, even if of sufficient length, were weak. Some poles could have been had from a tree called the iron wood tree. This wood, however, is of so close a grain and so very heavy that it was out of the question to use it. Many of the business streets were not more than from 20 to 30 feet across, including the sidewalks. Moreover, as curtains or awnings are stretched overhead from side to side by the owners of the stores to shelter and protect their goods from the sun's rays, it was impossible to erect a pole line down these streets, I found it better to run a two-inch iron piping up the side of the houses every 150 feet to a point 6 feet above the coping stone, and then attach to the top of this pipe a T, inserting in this T wooden cross arms to which the insulators were attached in the usual manner. It must be borne in mind that the houses are not of very great height. Where this arrangement was impracticable owing to the varying heights of the houses, I inserted strong iron brackets in the buildings set in with cement and well painted with rust-proof paint.

In India considerable care has to be exercised in putting up a pole line. If you want your work to stand any length of time, the base of the poles for one sixth of their length must be thoroughly well creosoted to resist as far as possible the ravages of an insect called the white ant or "termite." These insects live on wood. They attack even the wood-work of the houses and soon reduce the thickest timber to a mere shell. They live in trees and construct nests of great size like small sugar casks made of particles of gnawed wood and cemented by a kind of gluten. They are so strongly attached to the branches that they cannot be shaken down even by violent storms. It is a good plan to paint the poles eight feet above the surface of the ground with good gas tar if obtainable. In these climates special attention should be given to protecting the working parts of arc lamps, owing to the fact that rain occurs only for about three months of the year, and to make up for this loss the humidity of the atmosphere is remarkable. It is not at all infrequent to find early in the morning the bottom carbon holders full of water, unless provision is made for draining this off. During the hot season, a breeze springs up between 9 and 10 o'clock in the morning, and the ground being dry, the dust is terrific. Insects of a large size—much more so than those found in the northern climates—bats and small birds attracted by the glare are found either in the globes or lying at the base of the lamp posts in large quantities every morning; and the wholesale slaughter that takes place nightly seems to have no effect in diminishing these pests.

It was found better, therefore, on the arc service to give a man about 25 lamps to trim and clean per day, and the native entrusted with this work was held responsible, and if the lamps were found in a dirty condition he was fined, which usually had a good effect.

In the construction of station buildings one is guided much by the facilities for procuring stone, brick or other suitable material in that particular locality. Galvanized iron is sometimes used for roofing, but more frequently roofs are constructed of a sun-baked clay tile, provision being made as is usual for an ordinary wire tower for distributing the various circuits. A point to be noted is that the engineer should construct his rain gutters for taking off the storm water at least double the size that is ordinarily allowed for temperate climates. Roofs and the outsides of the buildings are white-washed.

To give an idea of the heat from the sun, I may mention that I had to replace considerable quantities of insulated wire after it had been up only a short time, the insulation in places sagging right away from the copper wire and finally dropping off. During the rainy season prevailing in the West Indies in the months of June, July and August, and in the East Indies, known by the name of the southwest monsoon, and prevailing from May to the latter part of August, electrical storms occur almost daily. They are often exceptional in violence, and much trouble and anxiety arises from possible damage to line, lamps and dynamos, even though provided by good lightning arresters.

While a heavy storm was in progress one night last summer in the West Indies, I noticed when in the station a curious effect of a flash that fused the lead strips on an ordinary saw-tooth arrester connected with one of the incandescent circuits. The strips were entirely destroyed or volatilized and what was before a polished plate of brass was now tarnished with a film of the lead vapor, and there was distinctly marked, as if photographed on the plate, a zig-zag streak, in all appearance like a photograph that had been taken of lightning. Engineers, during the prevailing season of storms, should take particular pains that their lines and machines are thoroughly well protected and that the arresters have good earth connections.

A sad case came under my notice that happened at a temporary installation for illuminating a camp in Poonah, in the Bombay Presidency, with arc lamps, in honor of a visit of an influential Rajah. Whilst the festivities were taking place in the evening, a heavy storm occurred. Lightning entered on the line, no provision had been made for diverting its course, and it destroyed the dynamo besides killing the native oiler who just at that moment was engaged in filling up the oil cups on the bearings. He was either thrown or fell across the commutator end of the dynamo, as he was found in that position, his hands much burnt, as well as his feet.

In the year 1877 the first commercial arc lamp was in use at the offices of the Bombay *Times*, and if I remember correctly it was the first light shown in the Indian Empire. From that date on, the demand for lighting has been on the increase; but pretty nearly all the work has been confined to isolated work and small central stations, cotton mills, sugar and indigo plantations, government buildings and large private dwelling houses. Places of business and offices do not require lighting, as business is conducted by the merchants only from 7 o'clock in the morning till 4 in the afternoon. The inhabitants of hot climates necessarily spend much of their time out of doors and are fond of social gaiety. They have been famous for centuries for skill in illuminating, and this fact has added much to the popularity of arc and incandescent lamps, which as is well known, particularly lend themselves to artistic illuminating purposes. From this knowledge, in the early part of the year 1885, I imagined that it would be a financial success to get together a travelling portable electric light plant, consisting of a vertical boiler, engine and two dynamos, one an 8 arc light machine and the other a 100 light incandescent, both mounted on a stout frame which rested on a pair of bisel trucks. This work was carried out, and I was kept actively employed for many months in going round to different large Indian estates and native palaces for the fetes that attend the various religious and family ceremonies that the wealthy natives are fond of indulging in. Large sums of money are spent and the festivities often last for a week or longer. It turned out to be as I surmised it would, a regular "bonanza," until on one occasion in bringing the unwieldy contrivance down a steep hill on one side of which was a ravine, it fell over; and it is needless to relate that the whole apparatus was seriously damaged. I found it would not pay to patch it up again, so, after stripping everything that was portable I left the remainder to lie and rust in the tropical vegetation.

Owing to the high price of coal, which is a costly article in the tropics, ranging from $8 to $50 per ton delivered, it is well to employ the most efficient and economical engine for motive power, more especially for central station work. In the station previously referred to, we were running with high speed compound condensing engines with satisfactory results.

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[1] A paper read before the General Meeting of the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

In many sugar plantations in the West Indies where the installations are of a comparatively small size, economy in this direction is not practiced as the amount of steam used is not missed, the boiler capacity on estates ranging from 100 H. P. to one at Cienfuegos, Cuba, of 2,500 H. P. It behooves the engineer, however, who has charge of a plant to exercise considerable care and watchfulness over his native firemen. The natives, as a rule, I have found, if treated with kindness and forbearance, show an aptitude in learning and taking hold that is often remarkable, more so than with some of their brethren of a lighter color who, because they have been taught how to start and stop a dynamo or trim an arc lamp, give themselves all the airs of an expert in electrical matters, and have got beyond that stage when they are willing to be instructed or to be obedient to orders, an unwillingness that sometimes leads to disastrous results.

The types of machines chiefly in use in the East Indies are those of English and French manufacturers, Siemens, Gramme, Silvertown and other well-known types. Those in use in the West Indies and South and Central America are generally of American make, and the market is not a small one. The great strides that both the foreign and home companies have made in the last two or three years in the supply and equipment of electrical plants for these distant lands are very evident signs that this particular business is receiving great attention at the hands of local merchants, planters and city or town officials and that they are more and more influenced by the many advantages to be gained by the use of electric lighting. Planters find now that it is much to their gain in a financial way. In former years, for example, the facilities of shipping their produce were restricted, and the work was done in daylight, and slowly. Now with weekly and almost daily sailings, it is an absolute necessity that they should get their produce ready with the quickest despatch possible, and this they do with the aid of the electric light. When an engineer is called upon to install or take charge of an electric light plant, it will be well for him to insist pretty closely not only that all the materials specified in the estimates have been shipped, but that every class of tool requisite for constructional work is included. Much time is lost and much trouble is made when you find that your outfit does not include "climbing spurs" or draw vises and other important articles. I have known engineers who have had expensive testing sets, Wheatstone bridges, reflecting galvanometers and other delicate instruments sent out with them, and then found that they had few or any tools to work with, and that the nearest hardware store was many miles away through a rough country, and even then the store, when reached, did not contain the requisite goods, there having been no stock kept because there was no demand made for them. Spare armatures, complete sets of arc lamp apparatus as well as duplicate parts of dynamos, spare brasses and gear for engines and tubes for boilers should always be included and it should be seen that they are shipped.

Apart from the vicissitudes incidental to life in the tropics, there is, I think, always a satisfaction and pleasure in the successful completion of an installation, knowing as one does that it is a potent factor in the greater civilization of those countries, demonstrating to the inhabitants, who have heretofore depended on artificial illumination of the same primitive character and manner as their forefathers used through ages past, what science, aided by her lieutenants, "pluck and energy," can accomplish.

THE INDUSTRIAL UTILIZATION OF THE COUNTER-ELECTROMOTIVE FORCE OF SELF INDUCTION.[1]

BY THOMAS D. LOCKWOOD.

It may as well be confessed at the outset that although my production has cost me considerable thought, it does not claim to advance any original ideas. Its claims to attention are based solely upon its merits as a chronicle. There seems to be among the modern race of electricans not a few who regard that species of counter-electromotive force which is the subject of this paper, as being the only species in the genus. While of course this view is erroneous, it is easily accounted for by the notorious fact that the American electrician as a class has little time to study. The fact, however, while it is indeed as I have termed it, "notorious," is still to be deplored; for it is certain that were electricans fully informed not only of the researches which took place before their own, together with the results of the said researches, whether these results took the form of success or failure, there would be much less valuable time wasted in supposed original research; there would be far fewer valueless inventions produced; and there would be a much smaller amount of subsequent vexations and useless litigation.

While counter-electromotive force, generally speaking, is a genus, the counter-electromotive force of self-induction is a species, and while an illustration of this statement will no doubt to most of us be an operation something in the nature of carrying coals to Newcastle, or water to the Mississippi valley, I cannot believe that it will be a waste of time, since doubtless we have many members who have not fully considered the subject.

Consider for a moment a definition of electromotive force. What shall we say it is? It certainly is not a natural force like gravitation, and I do not think we can do better than concede that we call it a force, simply because it is convenient so to do; and define it as any agency tending to set up that form of motion or vibration which we call electricity; or, if you please, any agency tending to the manifestation of electricity.

We are constantly hearing that a current of electricity is the result of a difference of potential between two points connected by a conductor; but though this statement through constant repetition has come to be as it were "human nature's daily food," I am inclined to consider it as being after all but a mathematical way of saying that a current of electricity is the necessary result of an electromotive force provided with a closed conducting circuit. For it is the electromotive force which first determines the difference of potential, which therefore may be considered as being a kind of initial result. Following out this train of thought, it appears then that electromotive force is a function of the source or instrumentality which develops the current, and expresses the totality of difference of potential in the entire circuit; and while we may properly speak of the difference of potential, or fall of potential between any two points on the circuit, I think we can not with equal propriety speak of the E. M. F. in any other way than as something pertaining to the source.

And further consideration of the same idea, shows the incorrectness of the popular phrase often used of late years, even by many eminent and able electricians, "a *current* of so many *volts*," the electromotive force being in no sense, near or remote, an attribute of the current.

To run counter to anything, is to run against it, to run in opposition to, to act opposedly; and so a "counter-electromotive force" may be defined as any agency tending to develop a current of electricity in a circuit, opposite in direction to that of the current excited therein by the initial electromotive force.

A familiar instance is that of connecting up in an electric circuit a certain number of cells in opposition to a number of other cells. This constitutes a primary counter-electromotive force and its inclusion in the circuit reduces the current in two ways; first by reducing the acting electromotive force to a value equal only to the algebraic sum of two opposing forces; and secondly, by adding internal resistance of the value of the cells added in opposition.

Another familiar illustration is found in that ingenious class of dynamo regulator, which acts by causing the opposing brushes to creep around the commutator and, according to the work which is being done in the external circuit, to include in the circuit (by increasing or decreasing the lead of the brushes) a greater or less number of armature coil sections exerting an electromotive force in opposition to the electromotive force which is developing the working current.

In these cases a utilization is made of counter-electromotive forces deliberately organized for the purpose, but they are not counter-electromotive forces due to self-induction.

At a very early period in the history of voltaic electricity it was discovered that there was some deteriorating force at work in every voltaic battery which depreciated the current to a much greater extent than exhaustion of the liquids or consumption of the solid elements could account for; and in 1801, Gautherot found[2] in this phenomenon which has foolishly been called "polarization," the germ of the secondary cell. He discovered that wires of platinum or of silver which had been used to decompose salt water acquired a power of themselves yielding a current when placed in acidulated water, and could cause muscular contractions of a frog's leg and produce the galvanic test. And subsequently it was ascertained that the operation of a voltaic battery tended to coat the negative plate with hydrogen which tended to set up a counter-electromotive force between the hydrogen and the surface of said plate, which thus reduced the available energy of the battery, and that this action could be transferred to the electrodes of the same battery if placed in a separate decomposing cell, and there tended to form electrically opposed surfaces which could themselves be used to develop a current in a direction opposite to that of the original current. As we all know, this operation, long regarded only as an unmitigated evil, is now utilized in the formation and operation of cells adapted for the electrical storage of energy.

The counter-electromotive force of self-induction distinct from the foregoing, is that discovered by Professor Henry; and its most important use is that which has been mainly brought out in association with the employment of alternating or other currents for the purpose of regulation. By reason of the fact that *this* utilization has proved to be overwhelmingly important, the electrical fraternity has partially lost sight of many earlier and contemporary instances of the useful employment of self-inductive electromotive force; which is indeed a close analogue in its character, mode of generation, and capabilities of use in regulation, to that developed and utilized in the operation of electro-motors.

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[1] A paper read before the General Meeting of the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

[2] See Izarn's Manuel du Galvanisme, Paris, 1804, and Phil. Mag., 1806, Vol. xxiv., p. 185.

First—I desire to point out that though Henry was the first to study and discuss self-induction, he was not the first to notice its effects.

Until quite recently I, together with nearly everyone else, had supposed that the earliest published notice of this phenomenon was Henry's account[3] of his observation, published in 1832; but I have in my researches on the subject, dug out the fact that this is not so. I find that an experimentalist, Vassali-Eandi by name, records that[4] with a pile of fifty pairs he found that the fluid passed along a copper wire plated with silver, 1,151 feet in length, in a time incommensurable; the shock in this case was three times as strong as that experienced by immediately touching the two extremities of the pile.

The above isolated statement of facts stands as I believe alone, and there is no record that it led to further research.

Henry on the contrary perseveringly pursued, and made himself master of the subject; and the record of his original observation, brief though it is, details the appearance of a vivid spark on the breaking of a battery circuit, if a wire thirty or forty feet in length be included in that circuit; he shows that the effect is increased by coiling the insulated wire into a helix; and that the effect depends in some measure on the length and thickness of the wire. The note concludes with these remarkable words: "I can account for these phenomena only by supposing the long wire to become charged with electricity which by its reaction on itself projects a spark when the connection is broken."

This, though brief, is then the first analytical notice of the electromotive force of self induction, so long erroneously denominated after its result, the "extra current."

It is unfortunate that Prof. Henry did not for some time pursue the subject, and we do not hear from him again until March, 1835.

Meanwhile his great contemporary, Faraday, had taken it up pursuant to an observation of one William Jenkin, and showed self-induction to be a corollary of his former masterly experimental researches in magneto-electro induction.

Faraday notes[5] the following points: Self-induction exists in simple helices as well as in electro-magnets, though not to the same degree.

Helices are superior in developing induction to straight wires, and long wires to short ones.

Self-induction practically disappears when the conductor is permitted to inductively act upon a neighboring closed circuit.

The amount of self-induction depends upon the length of wire exposed to inductive action.

An iron core within helices, much exalts the action of self-induction.

The self-inductive effect depends not "upon a permanent state of the core, but on a change of state."

Henry now again takes up the matter and in a consecutive series of papers, practically runs it to earth.

[6] In a paper of March, 1835, he gives more in detail some of the conditions of the development of self-induction. A long wire is better than a short one; a helix better than a straight wire of equal length. He also describes a shocking coil, and also a deflagration coil of but one wire in which self-induction is involved.

[7] A little later he elucidates the origin and properties of self induction and records that some additional energy appeared when iron was used as a core, but not much, because his coils were flat and not elongated helices. He ascribes all of these effects to dynamical induction, and shows that in a coil of a number of convolutions the convolutions act inductively on each other, and inferentially that the energy of the self-induction is the sum of that of the different coils.

[8] In a third paper further experiments in self-induction or with the extra current, as it was then called, are discussed. We learn that the electromotive force of any self-induction coil within certain limits is dependent upon the length of the coil.

That the form of the coil has considerable influence on the intensity of the action. In the experiments of Dr. Faraday, a long cylindrical coil of thick copper wire inclosing a rod of soft iron was used.

This form produces the greatest effect when magnetic reaction is employed.

The "extra current" of self-induction developed in a coil, is controllable by the presence of an immediately adjacent independent coil. It is energetic when the circuit of the adjacent coil is open but absent when the adjacent circuit is closed."

Of course it is impossible in this paper even to indicate the many good things which are spread before the reader of the researches of both Faraday and Henry. They are well worth study, and in fact they laid a solid foundation for the work which is being done now.

Both discovery and invention are displayed in their work, much of which has only found its sphere of action within the last four years; for it is emphatically true as has been said by Mr. W. H. Preece, "that though we are accustomed to hear that necessity is the mother of invention, the child is as a matter of fact often born before its parent.

As is frequently the case with electrical discovery, self-induction was long recognized, that is for the most part and by the generality of electricians, only as an unwelcome guest whose parting was to be speeded.

It was manifested mainly by an undesirable spark appearing upon the break of electric circuits in telegraphic, scientific and medical apparatus, and tending to burn away or oxidize contact points; while in the case of the two wire induction coils its effect was to reduce the spark passing between the terminals of the secondary; and many have been the expedients, wise and otherwise, which were devised for its banishment. Many of these were patented; more were not, inasmuch as the fever for patenting everything from a solar system to a thought had not then come into fashion.

Examples of this class of expedient are, respectively:

British Patent, No. 12,772, September 20, 1849, granted to those old heroes of electric lighting history, Staite and Petrie, which has for its 18th clause, a mode of "preventing the spark when breaking contact in galvanic circuits. A thin platinum wire may still convey some portion of the current after the main circuit is broken, or a series of sufficiently long conductors may break contact one after the other." The preferred way, in plain English, was to connect a fine wire as a shunt round the break, and thus to furnish a closed circuit in which the self-induction circulated its current of breaking.

United States Patent, No. 33,269, granted to J. E. Smith, September 10, 1861, for a means of preventing the spark between the local points of a relay on breaking the circuit; shunting the break by a wire having two terminals dipping into a bottle of water.

Moreover, as is well known in the ordinary induction coil, the action is emphasized by shunting the primary break by a condenser as first suggested by Fizeau.[9]

This, as I shall point out later, is a real instance of the industrial utilization of self-induction.

Other early investigators in this line reduced the spark of breaking the circuit, by wire shunts also.

Although, as I have stated, the recognitions of self-induction were mostly recognitions of an adversary, there were one or two early instances where the enemy was subjugated, and made to expend his energy usefully. The most notable instances of this are the single wire spark coils of Page and Callan[10] which were made especially with a view to exalt the self-inductive effects, and with which metals were fused and electrolytes were decomposed.

These were the forerunners of the spark coils used at the present day in electric gas lighting and comprising a single long coil wound to a suitable length upon a long core of iron wires.

There can, however, be no doubt that the principal attempts to make useful the counter-electromotive force of self-induction, and likewise the principal successes achieved, have been in the line of controlling, regulating or modifying the original, initiatory, or primary currents from which they have been developed.

I have compared this to the transposition of a given number of battery cells.

This analogy is however imperfect, since in cells of battery we may for the sake of argument regard the E. M. F. as being practically constant. Certainly they will in no sense regulate themselves in accordance with conditions automatically, but the inductive resistance *will* do this. For it is dependent for its efficiency as a generator upon the strength of current flowing through it. Therefore, if the current through it, due to the impressed electromotive force, from any reason falls, the counter-electromotive force will also diminish and thus will permit a greater amount of the initial force to act; or, in other words, will permit the impressed energy to become more effective. Suppose we have in the main circuit of an alternating dynamo, supplying a number of incandescent lamps in bridges uniting its mains, an adjustable resistance; and suppose the inductive resistance, which we may also regard as a counter E. M. F. generator, to be initially adjusted, so that all of the lamps burn brightly; then within limits of considerable range the current will be kept steady even though the applied E. M. F. fall or rise, or though the external resistance of the circuit be varied by lighting or extinguishing lamps.

For if lamps be extinguished and their branch circuits be opened, the external resistance rises and the current falls. It is true that the reduced current has not now so many branches to divide through, and that therefore self-regulation even without counter E. M. F. might be expected, but in systems of considerable magnitude it is not found to act practically, as well as it theoretically should. But here the useful effect of our self-induction regulation comes into play; and since the current acting upon the regulator is lowered, it is caused to develop a counter E. M. F. of less value, and thus to oppose less energetically the applied E. M. F., which therefore is brought to a greater extent into action, to overcome the increased resistance, and to maintain the normal current for the remaining work. So, if the applied potential falls, the current in consequence falls with it, and the counter E. M. F. developed falls also, and enables more of the applied E. M. F. to come into action. And the converse is true, if the current in the circuit from any other cause rises. Such an appliance would be still more convenient in connection with an arrangement of arc lamps fed by alternating currents, and connected up in parallel circuit, since the resistance of arc lamps would constantly be changing,

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[3] Silliman's American Journal of Science, July, 1832, Vol. XXII. pp. 403-8.

[4] Philosophical Magazine, Vol. XV. 1803; also Phil. Magazine, Vol. 3, 4th ser. 1852, p. 455.

[5] Experimental Researches in Electricity, Faraday, 1839, Vol. I, Ninth series, pp. 332-343, read before the Royal Society, Jan'y 29, 1835. A series of notes "The Influence by Induction of an electric current on itself."

[6] Journal of the Franklin Institute, March, 1835, Vol., XV. pp. 169-170, Sillimans American Journal of Science, July, 1836, Vol., XXVIII, pp. 327 and 331 and Scientific Writings of J. Henry, Washington, Vol., 1, pp. 87-91.

[7] Transactions American Phil. Soc., N. S., Vol. V., pp. 223-231, reprinted in Sci. Writings, J. Henry, Washington, 1886, Vol., 1, pp. 92-100.

[8] Transactions of American Phil. Soc. Vol., VI., pp. 303-337, Nov. 2, 1838.
Silliman's American Journal of Science, March, 1840, Vol. 38, pp. 209-243.
Scient. Writings of Joseph Henry. Washington, 1886, Vol. 1, p. 108.

[9] Comptes Rendus, Vol. xxxvi., p. 418, 1853.

[10] Sturgeon's Annals, Vol. i., pp. 290-302.

This has been so prominently brought before us by its most modern employment, namely by its well-nigh involuntary use in the distribution of electricity by means of alternating currents and transformers or converters having their primaries connected in parallel between the two mains of the source; and by the inductive resistance regulating device, patented by John Hopkinson, in England, August 3, 1881, No. 3,362, and in the United States, November 5, 1889, No. 414,541,—that many persons have actually been led to believe that such use is really a new thing.

The employment in the regulation of electrical distribution of counter-electromotive forces set up by the working currents themselves and proportioning themselves automatically to the work being done, is one of the most valuable and interesting features of modern electrical work; and, though such regulation requires to be supplemented by auxiliary arrangements, and though the belief of some that it could be attained absolutely without any waste has not been completely realized, still by availing ourselves of this feature we are enabled to control electricity with a facility and under conditions which otherwise would be unattainable.

The Hopkinson invention consisted in associating with an arc or glow electric light circuit employing alternating currents, a variable inductive resistance. This in one form was made by coiling a ribbon of thin sheet iron into a ring form, the different layers being separated by an insulating layer, and then by winding a number of coils of insulated wire on this ring, their adjacent ends being connected with plates between which contact plugs could be inserted, so that any number of the coils could be introduced or cut out from the circuit. Another form embodied the same principles, but had not a closed core. This form had a horse-shoe core made of an electromagnet formed of layers of sheet iron insulated from each other. The legs of the core are surrounded with the coils, and the said core has an armature also made of insulated layers of sheet iron. In this form the armature is clamped down; but the regulability of the appliance is attained by moving the magnet core further into, or withdrawing to a greater or less extent from, the surrounding coils. The form first described is in the British Patent shown as being included in circuit with the two mains of a dynamo; incandescent lamps being in cross bridges between the said mains; while in another figure arc lamps are in parallel circuit with the mains, an inductive resistance being included in each branch for each lamp and acting as an equalizer.

The iron core closed on itself to form a complete magnetic ring in which the lines of force are concentrated through the coil, and forced to cut all convolutions when exposed to reversals; the laminations at right angles to the currents, acting to facilitate magnetic change, to diminish hysteresis, and to prevent the circulation of eddy currents; and the insulation of the said laminations aiding in the latter function; all tend to show that this is a very highly organized appliance and is not only well adapted to produce a very high degree of self-induction, but combines most of the best arrangements tending to that end, and it is therefore not suprising that its invention and use made a strong impression upon the electrical mind, and caused a revival of the idea that regulation on these lines was capable of being accomplished, to use the words of the patent, "without wasting energy." Without materially wasting energy would perhaps be more strictly accurate, for by its use a small amount of actual resistance coil is enabled to do the work of a very much larger amount.

I have certainly no desire to detract from the great merit of this application, but an honest chronicler has no choice and must say what has been done, and it must therefore be stated that inductive resistances and other self-induction appliances had long been used both experimentally and commercially; no doubt often with but an imperfect conception of their mode of operation.

[11]Poggendorff's researches into the action of induction coils disclose a remarkable state of affairs for so early a date. These show that one induction coil was employed to send a current through the secondary helices of two others. The first coil thus acted as an alternating generator, and the two others as inductive resistances.

The primaries of two induction coils were connected in parallel and also in series at different times. Thus, to quote Poggendorff's own words, "two instruments (induction coils) A and B, were so combined that the current traversed the two primary coils one after the other; the induction coils (secondaries) however, were separated and A was allowed to give sparks, whilst B remained unclosed and without a soft iron core; the introduction of the latter into B, weakened the sparks of A, and the subsequent metallic closing of B reproduced their former strength "

The proper arrangement of induction coils is then discussed and whether the primaries should be connected in series or in parallel circuit. It is shown that the latter way is the proper one, and why. Then the paper goes on to say: "With respect to the cause of these phenomena it is no doubt to be sought in the extra or inner induction current. The outer induction current which is produced by breaking the inducing current has the same direction as the latter; whereas the extra current, which is at the same time excited in the induction wire, has a tendency to weaken the first induction current, and the more so the stronger the extra current, which latter is especially strengthened by the soft iron core.

"Consequently when the primary coils of A and B are connected one after the other, it is clear that the insertion of the soft iron core into that of B, will strengthen the extra current in that of A, and therefore weaken the induction current of the latter instrument.

"By connecting the instruments side by side a close circle is at once formed by them, and the extra current produced by the insertion of the soft iron core into B acts against that in A, and may therefore, when both are equal, completely neutralize it, when the outer induction current of A will necessarily be strengthened.

"Without the circle formed by this combination, *i. e.*, in the wire leading back to the voltaic battery, the two extra currents act, of course, in the same dir ction and strengthen one another, in consequence of which the sparks at the current breaker are still very active."

These considerations of Poggendorff show that even at this early period a great flash of light was thrown into the darkness which hitherto had obscured the reactions of self-induction, and though we have largely failed to use that light until quite recently, this is chiefly attributable to the same oft recurring reason, that there was really little call for it; hence it was soon hid under the bushel of the results of research on other subjects of more immediate interest.

The statement which I last quoted, brings me again to the application by Fizeau of the condenser as a shunt to the vibratory break, and to its operation.

[12]As shown by Lord Rayleigh, the condenser operates by producing electrical oscillations, and in its action the spark at the contact breaker is greatly decreased and the spark between the secondary terminals greatly magnified, because at the break the condenser is virtually an inductive reservoir, being an electrostatic shunt. And being an electrostatic shunt, the energy it momentarily absorbs is returned reversely to the primary circuit, just as in the discharge of a secondary cell, and increases the inductive variation in the secondary circuit during the brief period of time immediately after the break. And as the electromotive force in the secondary is thus exalted it is not difficult to see why the condenser increases the sparking distance.

As early as December 6, 1862, a patent for cable working, No. 3,453, was taken out by C. F. Varley, which describes the use of a self-induction resistance. This patent says: "A second circuit from the cable to the earth, independent of the receiving instrument is formed, by means of a resistance coil with a large iron core. It may be advisable to connect the cable to earth through an induction coil consisting of a large bundle of iron wire, surrounded by a long length of fine wire, the action of which is as follows: On reversing the battery connections the induction plates (condenser) and battery combined, send a short impulse into the cable, which divides; one portion into the cable, the other through the induction coil to the earth. At the first moment, the iron of the core opposes the passage of the current; consequently, during the first instant of time nearly the whole force of the current is applied to the cable. As the iron becomes magnetized to its maximum, this opposition ceases, but the plates have been charged in the opposite direction, and there is no longer any current passing from them into the cable to maintain the magnetization of the iron, the demagnetization of which, induces a current in the coil, and discharges the cable. In this way each impulse is followed by a short impulse in the opposite direction One of the figures of the patent shows that the wires of the core are made long, and are turned back on all sides over the wire of the coil, so as to entirely encase it. This feature was in conformity with a previous British Patent, No. 3,059 of 1856. The arrangement however clearly shows a use of a self-induction coil as a current controller, and indicates the function of a large iron core.

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[11] Poggendorff's Annalen, Vol. xciv., p. 2, and London and Edinburgh and Dublin, Phil. Magazine, 1855, Vol. 10, 4th series, p. p. 136-137.

[12] Phil. Mag., Vol. xxxix., p. 428, et seq.

We next find the counter E. M. F. of self-induction coming into use in connection with fast telegraph systems. Arrangements for its use are shown in the United States patents granted to Mr. Edison. These are respectively, No. 135,531 of February 4, 1873; No. 141,773 of August 12, 1873 and No. 147,313 of February 10, 1874.

The first and second disclose a shunt circuit, including an electro-magnet connected round the receiving instrument of a chemical telegraph. The first also shows a leak to earth from the line, which leak includes an electro-magnet. In both cases the object is to utilize the discharge current developed by the electro-magnet in the regulation of the operation and to produce sharp and clear signals.

The third describes the use of electro-magnets in shunt circuits round the transmitting and receiving instruments of an automatic telegraph system, and is said to be an improvement on the first. A number of electro-magnets are shown and by means of a switch one or more of these may be introduced. In other words the inductive resistance is here adjustable, and is operated by breaks, not by reversals.

British Patent No. 3,935, Nov. 14, 1874, to Alexander Melville Clark, for a chemical copying telegraph, uses induction and other coils to clear a line by the self-inductive counter E. M. F. By the decrement or cessation of the impulse, (as the patent states) the strongest depolarizing effects are produced, and the line is successfully cleared.

Next come four other patents to Thos. A. Edison. These are: U. S. Patent, No. 168,243, of Sept. 28, 1875, for an automatic telegraph. This, as in the previous cases, employs an electro-magnetic shunt.

U. S. Patent, No. 168,385, of October 5, 1875, Duplex Telegraph. This is an excellent example of self-inductive regulation. The counter E. M. F. is developed from electro-magnets in a changing electric circuit, and the coils have cores closed on themselves.

The next two, No. 173,718, of February 22, 1876, for Automatic Telegraphy; and No. 178,221, May 30, 1876, Duplex Telegraphy, involve no new principles and are like the preceding ones.

[13]Much information regarding the subject and further examples of its practical application can be found in a particularly able paper on "Shunts," read by William H. Preece, before the Society of Telegraph Engineers in 1887. The subject of the counter E. M. F. developed in electro-magnets is discussed, and the increase of the same, when the iron core is endless, is determined and pointed out; a good many instances of the practical uses of the self-induction shunt are described.

U. S. Patent, No. 207,724, of September 3, 1878, granted to Thos. A. Edison for a Duplex Telegraph, shows an electro-magnetic coil and closed magnetic circuit core placed in each branch of a Wheatstone bridge duplex telegraph, to counteract by its counter E. M. F. of self-induction the discharge of the electro-magnets in the bridge circuit. In Culley's "Handbook of Practical Telegraphy," London, 1878, p. p. 303 to 304, also p. p. 305 and 411, the regulation of currents by inductive resistances is considered.

In the first instance, the counter E. M. F. of an adjustable series of electro-magnetic coils is used to delay the discharge of a condenser in a duplex system. This is closely analogous to the function of the Hopkinson device, and is very suggestive. The reference on page 305 states that "static discharge can be entirely compensated for by the use of an induction coil, or a series of electro-magnets instead of a condenser."

U. S. Patent, No. 227,039, of April 27, 1880, to Muirhead and Winter, for a Quadruplex Telegraph, describes electro-magnetic shunts for reversing keys and relays, which are to counteract by their discharges electrostatic retardation. The specification says: "The electro-magnets may be of the well-known closed horse-shoe form, or they may consist of a single rod of soft iron with flanges of soft iron and a cylindrical casing of iron closing over the wire and connecting magnetically flange with flange."

U. S. Patent 231,904, September 7, 1880, to Joseph E. Fenn, Duplex Telegraph, shows an electro-magnetic generator of counter E. M. F. in the line circuit to counteract effects of discharge. It is made with a closed magnetic circuit, a separate coil being on each leg of a multiple pole core; several of these poles are made with yokes, and the combined yokes can be made magnetically continuous or discontinuous, at will, by means of iron plugs which can unite the different sections of core.

A book published in 1880, by Louis Schwendler, and entitled, "Instructions for Testing Telegraph Lines, and the Technical Arrangements of Circuits," Vol. 2, p. p. 144-147, gives a description of an electro-magnetic shunt and its operation. It is made like an ordinary electro-magnet, but has an adjustable wedge-shaped armature in contact with the cores. This of course operates by utilizing the counter E. M. F. of self-induction which developes currents that circulate through the shunt, and sharpen the signals.

In telephony also, as in other fast systems employing rhythmical currents, the counter E. M. F. has by no means been idle. As in telegraphy, our early acquaintance with it was an unpleasant one. Many of the earlier telephone lines were connected with a number of stations, and at each station there was of course an electro-magnet to operate the call. In some cases this was a telegraph relay, and in other cases a bell magnet. But in either case it was found, as indeed might have been anticipated, that the telephone currents had a decided repugnance to pass through the intervening electro-magnets on their way from one station to the other. To quote the graphic words of one of the patentees of devices intended as remedies for this trouble, it was found that electro-magnets were to a large extent "opaque to telephone currents."

Of course this is due to self-induction. The resistance of the line or the magnet coils had little or nothing to do with it. The convolutions however had, since it is clear that the electromotive force of the self-induction was proportional within certain limits to the number of convolutions.

The same difficulty appeared also in exchange work, where between any two connected lines was interposed an annunciator, to give from either end station a disconnecting signal. Several devices have been suggested for the removal of this difficulty and some of them have been patented.

Elisha Gray shunts the several interposed magnets by condensers; vide United States Patent, 203,264, of May 7, 1878.

F. W. Jones, attacking the same difficulty, shunts the interposed magnet by a non-inductive resistance controlled by the armature of the signaling magnet. See United States Patents, 238,399, of March 1, 1881, and 238,912, of March 15, 1881.

Other devices have also acted to shunt the bell or annunciator magnets in different ways; and still other suggestions have been, to surround the iron core with a brass sleeve, or with a closed circuit consisting of one layer of insulated wire; but these last, while certainly reducing the retardation, reduce also the magnetic power of the appliance. And there is no remedy so effectual as the absence of the interposed electro-magnet.

The service rendered by self-induction in telephony, and that which still may be expected, fortunately will probably outweigh the ills which it introduces. In many switchboard installations for metallic circuits, the supervising telephones are looped or bridged across between the two conducting links which unite one of the two metallic circuits with the other, and their self-induction prevents a material loss of current. Where from some condition of the service, such for example as the requirement of supervising both metallic and earth return circuits at the same switchboard, it sometimes becomes necessary in bridging the telephones to attach an earth branch to the connecting link on one side of the instruments; in this case it has also been found necessary in practice to place coils containing iron cores on the other side of the earth branch, so that not only the resistance but also the self-induction may be balanced.

It has also been ascertained that many telephones can at different stations be placed across from one wire to the other of a metallic circuit without any perceptible diminution of the effect at any one of them. This is one of the most important results of the self-regulating attribute of self-induction.

Perhaps, however, the most valuable instance of turning an electrical enemy into an electrical ally, is the way in which, by the proper use, construction and arrangement of electro-magnets, a plurality of either telephonic or partially telephonic and partly telegraphic messages may be transmitted over the same circuit at the same time.

The pioneer in this kind of work was C. F. Varley, who as early as 1870 took out a patent, No. 1,044, in England, for a combined simultaneous ordinary Morse and harmonic Morse transmission over the same wire; in this system the straight Morse was worked through electro-magnets, while the harmonic branches were led off from the main line from points outside of the electro-magnets.

Carrying on this line of invention, Mr. Van Rysselberghe, of Belgium, and Dr. Rosebrugh, of Toronto, Canada, have worked out systems whereby telegraphy and speaking telephony can be at the same time operated over the same circuit.

Since, however, there is enough in either system to fill up a paper devoted to them exclusively, and since this paper is already too long, I find it impossible here to describe them in detail, reserving this possibly for some future occasion.

Self-induction has also been caused to aid in eliminating the disturbing results of extraneous induction caused by parallel circuits, as in the United States Patent of Mr. Edison, No. 203,019, of April 30, 1878, where a telephone circuit is freed from external influences by combining it with an induction coil connected with the disturbing circuits in such a manner, that the direct disturbances received in virtue of the parallelism of the contiguous circuits is neutralized by an equal and opposite induction received also from them through the induction coil. This, however, is not a practical expedient.

Closely analogous to the self-inductive regulation of which I have been speaking, is that upon which the efficiency of an electro-motor depends. This was first observed by Jacobi[14] who says:

"Experimenting on the magnetic force of a bar of soft iron for which I could in no way account, I sometimes found considerable differences for which I could in no way account. I was curious to know if these differences proceeded from the nature of the iron, or from the weakening of the electric current produced by a voltaic pair of half a foot square of surface. For this reason, I placed in the circuit a galvanometer so distant as not to be affected by the direct magnetism of the bar. I was much astonished to see the needle recoil on placing the armature and advance on removing it, for it was the first time I had known the double quality of the connecting wire, viz., that of constructing the voltaic current, and at the same time representing an ordinary wire subject to the action of a magnet in motion. The spiral producing a magnet by the voltaic current is at the same time a magnetic electrical spiral in which a magnet is placed.

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[13] Journal of Society of Teleg. Engineers, London, 1877, p. p. 40-69.

[14] Sturgeon's Annals of El'y, 1837, Vol. i., pp. 408-419.

"Hence the solution of the uniform velocity of the magnetic machine. For being, set in motion by the magnetizing power of a voltaic current, it represents simultaneously an apparatus composed of magnets in motion and capable of producing a magnetic electrical current in a direction opposite to that of the voltaic current."

Jacobi, in a subsequent paper, practically elucidated the principles of the operation of counter E. M. F. in electro-motors, even as now understood, although he possibly did not state them as we now would. But he clearly showed that a motor may be regarded as a dynamo acting to develop an electromotive force, opposite in direction to that acting upon it, E. That the resultant force was of course $E-e$, and that this together with the resistance of circuit determine the strength of the current. That the motor utilizes $C\,e$ of the electrical power supplied, $C\,E$; and he furthermore showed that the power developed by the motor $C\,e$, is at its maximum when e equals one-half E.

It may be thought by some that considering the title of the paper, the principal utilization to which I have referred, viz., the use in regulation of systems of alternating currents operating converters, should have been discussed. It does not seem to me that it is necessary; this has often been done, and will again often be done by others much more competent than myself to handle the subject. But it does seem right that one should be found to give due credit for those who in the same line of thought are "not lost, but gone before," and I am glad that I am in a position so to do.

There seems little need for me to cite any more instances, showing that like nearly all new arts, the art of regulation by means of self-induction and of otherwise usefully employing the counter E. M. F. due thereto, is not *quite* new, and that while we can congratulate ourselves upon the achievements of the present, we should not fail to respect the foundation layers of the past, for of a truth, there were giants in those days.

ELECTRICITY IN THE NAVY.[1]

BY GILBERT WILKES, U. S. NAVY.

I HAVE taken as my title "Electricity in the Navy," and shall give in my paper the general conclusions derived from five years' more or less intimate connection with the application of electricity in our naval service.

The electrical engineer has little to do with the placing of the dynamo room, which is of necessity governed by the arrangement of the ship as a fighting machine. I shall, therefore, merely consider the power and apparatus of the plant, commencing with the engines.

Both in this country and abroad compound condensing engines have been used, some having separate condensers, some exhausting into the main condensers of the ship; but the preference seems to be in favor of simple double acting, high speed engines, the reason being that the power used for electrical purposes is so small in proportion to that of the main engines of the ship (only about an average of one per cent.) that the saving does not pay for the additional complication and cost. However, with a given plant, the engine should be constructed to allow little variation of speed under large changes of steam pressure, in order to take advantage of the main condenser when possible.

In our service both horizontal and vertical engines are now in use, the preference in some cases being the result of the shape of the available space. No data has yet been obtained as to the most economical type, but both are doing good service, the mishaps having been due to accidents. Of late years all of the engines put in for electric lighting have been high speed, the largest of about twenty-five horse-power and running at 400 revolutions.

The important points in the consideration of a marine dynamo are:

FIRST. It should be direct driven. The reasons are obvious, as not only is the space taken up by the belting valuable, but in a sea way the danger of running belts must be considered, especially when it is taken into account that naval vessels are fighting machines and the possibility of accidents must be reduced to a minimum.

SECOND. It should be compact. This is a natural extension of the above. Even now it is difficult to find room for all the machinery, stores and ammunition, besides providing room for berthing the crew on a modern man-of-war.

THIRD. It should be free from liability to injury by salt water, and not too subject to mechanical damages.

In this respect there remains room for considerable improvement, the latest dynamos now better filling this requirement than did the old "L" machine on the Trenton in 1883, the first dynamo afloat in our navy, and which ended its useful career in the great storm at Samoa last year, when it ran until the water had put out the fires under the boilers.

On board ship salt water and damp air get everywhere, and within the last year a number of cases of slight burn-out have occurred in armatures, which, when installed, measured high in the hundreds of thousands of ohms insulation. The dynamo should not be easily harmed. The dynamo room is now always low down in the ship, under the protective deck (if there is one), and when the light is not in use the room is very dark, rendering careful inspection difficult.

FOURTH. The dynamo should have small effect upon the compasses. This point has received little attention, though it is a matter of great importance, as the effect on many vessels is so large that, in order to work up the day's run, it is necessary to know the hours during which the dynamos have been in operation. Complete deviation tables are, therefore, necessary for the two cases. In different types of dynamos the effect with a twenty horse-power machine, at a distance of twelve feet, will vary from less than one-twentieth of the horizontal component of the earth's magnetism to several times the strength of the horizontal component. The latter is, unfortunately, rather the rule than the exception, and, in consequence, the position of the dynamo room has to be well borne in mind in locating the standard compass.

FIFTH. It should be easy in running and require but little attention. The machine should be non-sparking, under constant load and also be able to stand sudden large changes of load with little sparking. This is necessitated by the fact that the dynamos now supplied for incandescent lighting are also used for search light work, and the conditions are aggravated by most of the search lights having hand regulation only. Thus, with a 200 ampere machine, not only are from 50 to 100 amperes thrown suddenly on and off, but, at the moment that the operator at the projector brings the carbons together, the dynamo is suddenly called upon to deliver over three-fourths of its total capacity.

SIXTH. It should be efficient and run cool, the former in order to avoid the waste of energy and a corresponding amount of the coal supply, and also in order to avoid overheating. The dynamo rooms on ship board are, at best, warm, notwithstanding the motor fans, which are now usually supplied, and thus the safe limit of extra heating is reduced. At the same time consideration for the attendants requires that the cramped space be kept as cool as possible.

SEVENTH. The dynamo should maintain a constant potential at all loads. This is of course accomplished by compounding, and, as there is only about 3 per cent. drop, it is usual to compound exactly, or to only overcompound enough to allow for the decrease in the engine's speed with load.

EIGHTH. The dynamo should be light. The reasons are obvious, but it is considered last, because usually a careful study of the materials, and arrangement of the plant, can accomplish more towards reducing the total weight than the strict adherence to a specification of watts per pound of dynamo. Thus, consider the difference between the weight of a 40 horse-power ship plant on a five watts per pound specification and upon a four watts specification. Two 200 ampere, 80 volt dynamos, with their share of the bed plates, will only weigh about 7,500 pounds. Twenty per cent. of this will be 1,500 pounds, an amount a large portion of which can really be saved in some cases by more careful attention to the amount of wire and molding employed.

Naturally no one dynamo can best fill all of these conditions, and while the order in which they are above arranged will usually approximate to their relative importance, special cases arise which demand a re-arrangement. Thus, on torpedo boats, the most important quality is small size. With this in view, numerous devices have been placed upon the market and faithfully tried, but none have to my knowledge proved satisfactory. The requirements of high efficiency, low speed and low heating, all give way in this class of dynamo to the necessity of compactness and light weight. Good results were hoped for from the Parsons turbo-electric generator, but experience at Newport demonstrated that the turbine was so inefficient in its consumption of steam as to place its use out of the question. There is as yet no apparatus to satisfactorily fill this want.

Up to the present all of our ship plants contain two or more similar sets, each composed of an engine and one direct driven dynamo. The larger of these are of 200 amperes capacity; a very convenient unit, but one which can be doubled in capacity with advantage in ships which are not light below decks and which are likely to soon have extensive motor application; for example, vessels of the monitor type.

The voltage in use in the navy is 80 volts, this having been fixed upon as a mean between the most efficient pressure for the incandescent system and the voltage necessary for the search lights, to which current is supplied by the regular service machines. The incandescent lamps have given excellent results as to life from the very start, owing in great measure to the fact that low efficiency lamps are always used, nothing more economical than 4 watts per candle-power being usually required.

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[1] A paper read before the American Institute of Electrical Engineers, New York, May 20th, 1890.

Search lights of 50 volts and from 50 amperes up are used, 2 or more being supplied, according to the size of the ship. Some of these are imported, others are made in this country.

The two wire system has always been used in the naval service, the ship never being allowed to form the return circuit. On account of the present beginning of motor work on board ship and the future developments confidently looked for, the direct current has always been used. Motors have thus far been used only in driving small fans up to one-half horse power, for hoists, and in one case a motor has been used for training one of the large guns—on the "Chicago." There are numerous small engines about a man-of-war, varying from 1 to 50 h. p. Some of the smaller ones might even now be replaced with advantage by electric motors, but it must be proved in each case, that the motor not only does the duty as well as the engine it replaces, but also that it and any increase necessary in the generating plant take up less room and weigh less than the engine and its piping. This, of course, will always be the case where very small engines are replaced, and as the tendency is to increase the capacity of the dynamo plant, it may not be long before motors may look for a larger field on board ship.

All circuits are water tight from dynamo to point of distribution, the cut-outs having stuffing boxes through which the lead covered wires enter. Even the switches and attachment plugs for portables are required, in certain places, to be water tight.

One electrical application that presents many advantages on board a man-of-war, especially when on a foreign station, is electrical welding. However, when it is introduced on ship board, the pressure of the generator should be reduced to 80 volts, in order that in case of emergency it might be used for lighting purposes, while the welders should have several sets of adjustable clamps. Welding machines have not yet been actually used on ship board, but it is to be hoped that their introduction is a development of the near future. They cannot supplant any of the existing dynamos, owing to the necessity of motors, but must come in to occupy a place of their own, to almost entirely supplant the ship's forge and add to the general useful equipment.

Thus the man-of-war is the proper field for nearly every form of application of electricity, and when the storage battery becomes more suited to the service there required, there is no doubt that it too will come in for its proper share of usefulness.

As to the naval work on shore in the electrical field, little need be said, as the practice at naval stations must be similar to that in ordinary commercial work. However, a navy yard is an ideal place for the erection of a central station for light and power. The streets must be lighted; closely grouped about the station are offices and large shops needing light in the dark afternoons, and power for motor work; then in an outer approximate semi-circle lie the officers' quarters; finally there are anchor chains to be welded, boiler tubes to be repaired, and numerous other similar operations which can be better accomplished by the welder than by any other known means. This in an ideal plant will call for arc lights, incandescent lights, constant potential motors, a welding generator and welders. The complete combination will probably not be realized at any one place within several years, but a good beginning has been made in the arc light plant recently installed for outside and shop lighting at the Washington Navy Yard[2] and the progressive plan adopted by the Department leads us to hope that the shore stations will rapidly receive the benefits already enjoyed on ship board. Owing to the usually close grouping of the buildings and to the demand for motors, it is probable that only in exceptional cases will the alternating current be used extensively. Good use is already being made of small motors for drilling purposes at the New York Navy Yard, where several are in constant operation, having driven out the portable steam engine, countershafting and belting.

The applications of electricity in the navy have always been on the increase, and any one who has served one cruise with oil lamps and one with electric lights and motors will understand the favor in which the increasing use of electricity is held by the naval man.

New Bedford, Mass. Charles W. Clifford, counsel for the Southern Massachusetts Telephone Co., has served papers on President Hart of the New Bedford Street Railway Co. notifying him that the telephone company will hold the street railway company liable for any damage which might result to the telephone system through operating the road by electricity, and Walter Clifford, counsel for the street railway company, has served a notice on the telephone company that it would be held liable for any damage which might result from the telephone wires falling upon the electric railroad wires.

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[2] See The Electrical Engineer for full illustrated description May, 21, 1890.

THE LIMITATIONS OF STEAM AND ELECTRICITY IN TRANSPORTATION.[1]

BY O. T. CROSBY.

"Do you expect electric engines entirely to displace steam locomotives on all railroads?" That is a question which has doubtless been propounded to many electrical engineers. Its answer has doubtless been made, in general, by wise reference to the boundless possibilities of direct production of electrical energy from heat, and to Bellamy's "Looking Backward" storage batteries.

To make some study of the boundary line dividing the province of steam locomotion from that of electric locomotion—under existing conditions of producing electric energy—is the object of this paper.

In the light of present achievements I may state, without argument, the following propositions:

First—It is possible to construct motors capable of doing the maximum work required to-day in transportation.

Second—It is possible continuously to generate electric energy equal to the capacity of any number of such motors.

Third—At any desired loss and over any desired distance it is possible to supply by the running contact method, the necessary current, at considerable pressure, for the working of such motors.

Should there still be question in the minds of any, as to the value of the running contact method at speeds much higher than those commonly used, I may state that I have seen 75 amperes at 500 volts thus continuously supplied to a car moving at more than 110 miles an hour.

These premises being established, further discussion divides itself into three parts.

First, as to the mere possibility, without reference to the economy, of steam and electric propulsion under given conditions.

Second, as to the relative cost of exerting, in a locomotive, any unit of power by electric, as compared with direct steam motors.

Third, as to the relative amount of power required by the two agents to transport a given paying load under given conditions.

In using the word steam, as above, I have in mind only the direct application of steam power on the tracks. The case of cable propulsion is not here compared, as that has, within its restricted field of application, already been compared with horse, steam and electric power.

The limiting possibilities of locomotion may be understood by considering a prolongation of the lines of present practice in the direction, first, of loads handled; second, grades climbed; third, speeds attained; fourth, length of continuous runs.

Since the effect of grade, as compared with line, is simply to increase the tractive effort required for a given load and speed, it need not be separately treated, except that there has been some question of increase of adhesion, in the ground return method, which in extreme cases might appear as an advantage for electric propulsion. The matter is not of great importance, and I will refer to it only so far as to say that interpreting my own general experience and some special tests, the adhesion coefficient seems not increased in any practical degree by the mere passage of the current from wheel to rail.

The capacity of an electric engine, like that of a steam engine, to haul any given load, will be measured by the tractive effort possible to be produced and the relation between weight and adhesion for given track conditions. The ready multiplication of cylinders in the one case and armatures in the other, while maintaining mechanical unity as to drawbar division and the ready coupling of distinct locomotive units, renders the whole question of capacity to exert a given horizontal effort, without regard to the time element, unimportant and indefinite.[2] It goes without saying that, if desired, a single armature may be constructed capable of exerting as great a drawbar strain as any locomotive now in use.

As to limiting speeds, it is not easy to-day to make "an educated guess" either for steam or electric propulsion. The high figures for steam that have been recently presented, both from England and America, are higher than the limiting figures as they would have been given by many competent authorities only a few years ago. Eighty-six miles per hour in England, on the Northeastern Railway, eighty-seven miles per hour in this country on the Reading Railway, have both been reported since Jan. 1, 1890. These runs are noteworthy, not only for the fact of unusual

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[1] A paper read before the General Meeting of the American Institute of Electrical Engineers, Boston, Mass., May 20, 1890.

[2] As an interesting example of an unusual load in steam service, I may refer to one consisting of 156 loaded cars and two cabooses, hauled over the Mississippi Valley Railway, December, 1885. The load consisted of—

	Pounds.
Cotton weighing.	3,226,000
Cars weighing	3,239,000
Engine and tender weighing	147,000
	6,612,000

Speed was about 10 miles per hour.

speed, but because, as shown by indicator cards in the English case, and as may be deduced from the consideration of the maximum cylinder power in the American case, the train resistances are far below the values that would have been predicted by even the most liberal of the received formulæ on the subject. The total resistance per ton, as per indicator card in the 86-mile run, was only 13.4 pounds. According to Searles' formula, adopted by Wellington, it should be 69 pounds, engine and tender being taken at 50 tons. The load of 347 tons was carried at 86 miles per hour by an expenditure of 1,068 h. p.—this on a level. The engine was compound.

Would it be possible to attain a speed twice as great, or say 150 miles per hour?

A driver 24 feet in circumference would require to revolve 550 times per minute in order to travel 13,200 feet per minute, or 150 miles per hour—this without slip. Since in the case considered the revolutions per minute reached 309, and since in the Reading case a much higher rate must have been reached, the drivers being smaller, and since on stationary engines a speed much above 550 revolutions per minute has been attained, it seems beyond question that from this point of view the supposed case is quite possible.

Considering the matter of steam supply, we are again brought to consider the whole matter of train resistances at all speeds.

Total resistance to motion should be sharply divided into two classes: the resistance due to motion through air, and that due to friction and blows between vehicle and track, and to friction and blows between parts of the vehicle.

For the most part those who constructed the formulæ now found in text-books, worked on roadbeds far inferior to the best work of to-day, at speeds much less than those now attained and with wrong values for at least one of the species of resistance, the atmospheric. On this point I have recently been able to present as the results of experiments at high velocities, made by Mr. Benj. J. Dashiell, Jr., and myself, a formula showing the pressure to be a function of the first, instead of the second, power of the velocity as ordinarily assumed. A convenient datum point may be given stating that at 100 miles per hour the pressure on one square foot, normal to the direction of motion, is 13 pounds, while proper shaping of the front may reduce this 6.5 pounds.

The absolute values given, while corresponding quite closely with those of received formulæ in the neighborhood of the velocities heretofore experimentally attained, depart widely from those assumed for velocities higher than 30 miles per hour, and calculated by the quadratic relation between velocity and pressure. Using the more trustworthy values, I have been able to separate more nearly than has heretofore been possible the atmospheric from all other resistances met at high velocities. Some inaccuracy still remains, by reason of the difficulty of obtaining exact measure of the resisting areas in a train, but I have been able by study of careful tests made by others on the N. Y. Central and on English roads, to find that over the range from about 40 up to 80 miles per hour the tonnage coefficient seems practically constant at 8 pounds. This, of course, applies only to first-class roadbed and rolling-stock. Whether this coefficient remains constant at higher speeds we do not know. There is no reason to assume, as has often been done, that it increases with the square of the velocity, and on the other hand it will not be safe to assume constancy. From experiments made with a single 2.5 tons car at about 100 miles per hour, the tonnage resistance at that speed seems to be about 20 pounds per ton. Though this value seems quite high as compared with the eight pounds at 80 miles per hour, the difference is in large part to be explained by the poor condition of the track used for the experiment and a constant curvature which would call for about four pounds per ton. Until better evidence can be had it will be safe, at least, to assume a value of 20 pounds per ton, on a first-class track, with good rolling-stock, at 125–150 miles per hour.

Having made this necessary digression, we may return to the matter of steam supply, and state that by reducing weight and area, both to something less than one-half the original values in the 86 mile run, the same effort would produce the speed 150, instead of 86. The area cannot be thus reduced, but by assuming a greater reduction in weight—say to 100 tons, or to little more than engine and tender—maintenance of the higher speed becomes possible, with nearly the same steam expenditure as in the recorded case.

To attain that speed, from rest, might require such original weight of fuel and such length of favorable track as to make the feat practically impossible with steam. This leads us to inquire into the dead weight necessary for hauling, say, one ton at different speeds.

Table I. gives the horse-power required for exerting the tractive effort for one ton at various speeds, at various efficiencies, with various values of cross-section per ton, and with the two agents—steam and electricity:

Column 1 shows speed in miles per hour from 20 to 140; column 2, corresponding tonnage coefficient, or resistance, in pounds per ton, inclusive of atmospheric resistance. Columns 3 to 8 inclusive show horizontal effort needed for overcoming atmospheric resistance under various assumptions as to area exposed per ton, from 1 square foot to 0.1 square foot per ton. The former figure corresponds nearly to the case of a heavy locomotive propelling itself alone. As load is put on behind it, other ratios are formed. Oblique surfaces are supposed to be reduced to equivalent normal surfaces. Columns 9 to 14 inclusive show rate of work in horse power per ton, for the various cases of area exposed to atmospheric resistance, efficiency of locomotive being taken at 90 per cent. Columns 15 to 17 inclusive show h. p. per ton for the extremes and middle cases of exposed area, and for locomotive efficiency of 80 per cent. Columns 18 to 20 inclusive show same for efficiency of 60 per cent. Columns 21 to 26 inclusive show weight of coal and water per ton carried for one hour, assuming 5 lbs. of coal and 15 lbs. water per h. p. hour on a steam locomotive. The coal figure is very close to actual practice. The water figure is less, but makes allowance for scooping water at convenient intervals. Continuous scooping is not considered practical or economical. Columns 27 to 29 inclusive show weight of steam locomotive and tender required to generate the required h. p. per ton, under the assumption of 100 pounds per horse power and 90 per cent. efficiency. Only three cases of exposed area are taken; that is, one foot, one-half a foot, and one-tenth of a foot per ton. The weight of steam locomotives is not calculated for any other efficiency figure than 90 per cent., as this seems to be quite constantly attained or surpassed. The assumption of 100 pounds per horsepower is closely true for many good types of locomotive when working at speeds from 60 to 80 miles. At lower speeds this figure is too low, but it is assumed that for any ruling speed engines may be built of minimum weight for that speed. In passing through lower than ruling speeds, both electric and steam motors work at low output per pound of weight, hence the assumption of constant weight per horse-power will not introduce error materially affecting comparative results. At higher speeds than 80 miles existing engines would show less than 100 pounds per h. p.; but as their boiler capacity is reached at that speed, the necessary increase for any regular work would carry the weight figure to very nearly the figure given for the 60 to 80-mile running. Columns 30 to 32 show weight of steam locomotive and tender, plus weight of fuel and water, per ton hauled, also weight of load-freight and freight car that may be hauled; by such weight of motive power; the load figures being obtained by subtracting the motive power weights from 2,000 pounds. Columns 33 to 41 show corresponding figures for electric locomotives under the assumption of 60 pounds per h. p., and at the three efficiencies, 90, 80 and 60 per cent.

The 60 pounds per horse-power covers weight of containing car for motors. I cannot here go into detailed figures on this point, but believe that any investigation will find the figure safe, supposing always that the unit be, say, 25 h. p. or more. I also know of experimental work now progressing under most competent direction, which gives fair promise of leaving this figure much too high. Columns 42 to 53 inclusive show the horse-power required to be exerted for hauling one ton of *load, i. e.*, freight and freight car, the relation between these two being taken as the same for either steam or electric propulsion; hence not necessary to enter here. These columns apply to steam at 90 per cent., and to electricity at 90, 80 and 60 per cent., and for the three cases of exposed area. They are readily obtained from the previous columns by making allowance for the horse-power necessary to haul that part of every ton, total weight, which must go into motive power, machinery and fuel. Columns 54 to 62 inclusive show the ratios between horse-power required by the two agents for hauling a ton of *load* (frieght and freight car) at the different speeds, efficiencies and area relations.

It is plain that if we can now obtain the ratio of cost per horsepower hour, as given by the two agents, in the corresponding cases, we can easily determine the speeds at which the one or the other agent becomes the most economical.

Let us first obtain the cost in electric propulsion.

For this, form Table II., showing the elements in the cost of one horse-power hour in stations of various capacity—from 100 to 3,000 h. p. Engineers and dynamo-men are assumed to receive 40 cents per hour, and to superintend a maximum of 1,000 h. p. This would produce, in some cases, fractional engineers, as for a 1,500 h. p. plant, but such complication has been avoided by assuming a constant value per unit of power, in the pay-roll element in plants exceeding 1,000 h. p. Firemen and helpers are taken at 30 and 25 cents per hour, respectively. Superintendence, at 30 cents per hour, is apparently low, but is equivalent to 60 cents for daylight hours, since the plant is able to run 24 hours with the same general superintendence as for 12 hours. It is further supposed that the total of this item will not require increase until the capacity reaches 3,000 h. p., beyond which it remains constant per unit of power. As no other element of cost is supposed to vary beyond this point, the table shows here a minimum total cost per unit, and a constant cost beyond it.

Coal is assumed to cost $3.00 per ton, and to be consumed at the rate of 3.2 pounds per electric h. p. hour in the dynamo. A very slight error is made in taking the rate of consumption as constant while changing the capacity of the engines.

Cost of steam plant is taken to vary from $50 per h. p., in a small plant, to $20 in a plant of 1,500 h. p. This latter figure may

TABLE I.

Speed.	Tonnage.	Areas exposed per ton in sq. ft.						Rate of work in H. P., 10 per cent. loss.						H. P. at 20 per cent. loss.			H. P. at 40 per cent. loss.		
		1.0	0.75	0.5	0.25	0.2	0.1												
		Horizontal effort.						2 and 3	2 and 4	2 and 5	2 and 6	2 and 7	2 and 8	2 and 3	2 and 5	2 and 8	2 and 3	2 and 5	2 and 8
20	8	2.6	1.95	1.3	0.65	0.52	0.26	0.61	0.58	0.534	0.·01	0.49	0.48	0.70	0.07	0.55	0.93	0.8	0.73
40	8	5.2	3.90	2.6	1.3	1.04	0.52	1.56	1.40	1.23	1.068	1.05	0.99	1.77	1.40	1.12	2.37	1.86	1 5
60	8	7.8	5.85	3.9	1.95	1.56	0.78	2.77	2.48	2.09	1.75	1.67	1.54	3.15	2.37	1.77	4.20	3.2	2.37
80	8	10.4	7.80	5.2	2.6	2.8	1.04	4.32	3.70	3.00	2.46	2.35	2.00	4.90	3.50	2.37	6.53	4.6	3.2
100	12	13.0	9.75	6.5	3.25	2.6	1.3	7.32	6.35	5.40	4.45	4.27	3.90	8.32	6.15	4.42	11.1	8.16	5.9
120	15	15.6	11.70	7.8	3.9	3.12	1.56	10.79	9.39	8.03	6.65	6.37	5.84	12.21	9.12	6.66	16.8	12.2	8.85
140	20	18.2	13.65	9.1	4.55	3.64	1.82	15.67	13.7	11.88	10.06	9.75	8.95	17.80	13.5	10.17	23.6	18.0	13.5
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Speed.	Tonnage.	Coal and water for one hour. 5 lbs. coal. 15 " water.						Locomotive and tender at 100 lbs. per H. P.			Weight: machinery and fuel; and load. Steam. 10 per cent.			Weight: Load; and weight of machinery. Electric. 10 per cent.			Weight: Load; and weight of machinery. Electric. 20 per cent.			Weight: Load; and weight of machinery. Electric. 40 per cent.		
		2 & 3	2 & 4	2 & 5	2 & 6	2 & 7	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 and 3	2 and 5	2 and 8	2 and 3	2 and 5	2 and 8	2 and 3	2 and 5	2 and 8
20	8	12.3	11.66	10.65	10.12	9.9	9.6	61.6	58.3	48.4	73 1927	69 1931	57 1943	1964 36.6	1968 32.	1971 28.8	1958 42.	1264 36.	1967 33.	1944 55.8	1952 48	1956 438
40	8	30.8	27.9	24.6	21.30	21.07	19.8	154	139.7	99.0	185 1815	164 1836	119 1881	1906 93.6	1926 73.8	1941 59.4	1894 106.2	1916 84.	1933 67.2	1858 142.2	1888 111.6	1910 90
60	8	55.4	48.6	41.8	35.0	33.4	30.8	277	248	154	332 1668	285 1715	185 1815	1831 166.2	1875 125.4	1908 92.4	1811 189.0	1858 142.2	1892 106.2	1738 262	1908 192.	1858 142.2
80	8	86.2	73.9	61.8	49.3	47.1	42.1	431	370	210	517 1483	432 1568	252 1748	1741 259.2	1820 180	1880 120.	1706 294	1790 210.0	1858 142.2	1608 391.8	1724 276	1808 192
100	12	146.5	131.2	108.2	89.0	84.3	77.8	732	636	389	878 1122	744 1256	477 1523	1561 439.2	1676 324	1766 234	1500 499.2	1631 369	1735 265.2	1334 666	1510 489.6	1646 354
120	15	215.4	187.88	160.	133.0	127.4	116.8	1078	939	584	1293 707	1099 901	701 1299	1354 646.2	1518 481.8	1650 350.4	1268 132.6	1453 547.2	1600 399.6	1022 978	1268 732	1469 531
140	20	313.5	276.0	237.	201.0	195.1	179.1	1567	1380	895	1880 120	1617 383	1074 926	1060 940.2	1287 712.8	1517 483.	932 1068	1190 810	890 610.2	584 1416	920 1080	1190 810
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

Speed.	Tonnage.	Power for one ton, freight and car, steam. 10 per cent.			Power for one ton, freight and car, electric. 10 per cent.			Power for one ton, electric, at 20 per cent.			Power for one ton electric. 40 per cent. loss.			$\frac{\text{H. P. Steam.}}{\text{H. P. Elec.}}$ Loss on both, 10 per cent.			Ditto Loss Steam. 10 per cent. Loss Elec., 20 per cent.			Ditto Loss Steam, 10 per cent. Loss Elec., 40 per cent.		
		2 and 3	2 and 5	2 and 8	2 and 3	2 and 5	2 and 8	2 and 3	2 and 5	2 and 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
20	8	0.633	0.55	0.49	0.62	0.54	0.48	0.715	0.68	0.56	0.95	0.82	0.75	1.01	1.02	1.02	0.88	0.81	0.87	0.66	0.67	0.65
40	8	1.72	1.34	1.05	1.63	1.27	1.02	1.88	1.46	1.15	2.55	2.0	1.57	1.05	1.05	1.03	0.91	0.92	0.91	0.67	0.67	0.66
60	8	3.32	2.44	1.70	3.02	2.23	1.61	3.48	2.55	1.87	4.8	3.54	2.55	1.1	1.09	1.05	0.95	0.95	0.91	0.69	0.68	0.66
80	8	5.83	3.82	2.28	4.96	3.3	2.13	5.74	3.91	2.55	8.12	5.34	3.54	1.17	1.16	1.07	1.02	0.98	0.90	0.71	0.71	0.65
100	12	13.05	8.60	5.12	9.38	6.44	4.42	11.08	7.54	5.09	16.6	10.8	7.17	1.39	1.33	1.16	1.17	1.14	1.00	0.78	0.8	0.71
120	15	30.4	17.8	9.0	15.9	10.5	7.08	19.25	12.5	8.35	31.8	19.25	12.0	1.91	1.7	1.27	1.58	1.42	1.08	0.95	0.92	0.75
140	20	260.8	62.0	19.3	295.6	18.46	11.8	38.2	22.7	14.63	80.8	39.1	22.7	8.8	3.35	1.64	7.00	2.7	1.39	3.2	1.6	0.85
		42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62

seem too low to some, but I have recently seen the figures for an 800 h. p. plant, in a neighboring Massachusetts city, which cost, in place, at the rate of $22 per h. p.

Dynamo plant is taken to vary from $50 to $20 per h. p. in going from 100 to 1,500 h. p. I know that machinery of good design can be manufactured for these prices.

The cost of buildings is taken to vary from $25 to $10 per h. p. This is the most indefinite item. Interest, maintenance and taxes are roundly assumed at 10 per cent. per annum on the whole plant.

With Table II. as a basis, Table III. has been calculated, giving total cost per horse-power hour in stations of various capacities, working at various percentages of full capacity and for 24, 18 and 12 hours per day, respectively.

TABLE II.

Elements of the cost of one h. p. hour, electric, in cents.

Capacity....	100	300	500	800	1,000	1,500	2,000	3,000	4,000	5,000	6,000
Engineer..............	0.4	0.13	0.08	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fireman..............	0.3	0.10	0.06	0.037	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Dynamo man.	0.4	0.13	0.08	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Helper...............	0.25	0.08	0.05	0.031	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Superintendence......	0.30	0.10	0.06	0.037	0.03	0.02	0.015	0.001	0.001	0.001	0.001
Coal..................	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475	0.475
Oil, waste and water..	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Interest and depreciation steam plant....	0.057	0.051	0.044	0.033	0.028	0.022	0.022	0.022	0.022	0.022	0.022
Ditto, electric plant...	0.057	0.051	0.044	0.033	0.028	0.022	0.022	0.022	0.022	0.022	0.022
Ditto, building........	0.028	0.026	0.022	0.168	0.014	0.011	0.011	0.011	0.011	0.011	0.011

A glance at the table shows that in a 100 h. p. plant the cost varies from 2.42 cents for a 24-hour run at full capacity, to 8.06 cents for a 30 per cent. output continued only 12 hours per day.

This extreme case would doubtless be ameliorated by dropping the superintendence and combining engineer and fireman—though to this the unions might object. This capacity is smaller than need be considered for any steam-line service.

The minimum cost given by the table is 0.816 cent; this for a 3,000 h. p. plant, working full capacity 24 hours per day.

The next element of cost—that of the conductors for the current—is obtained from Table IV. showing investment in dollars for the copper required to transmit one h. p a distance of one mile, at varying initial and final pressures. The constants for this table were thus obtained: Taking a well-known line wire, I find that from No. 4 to No. 000 B. W. G., the average weight-ratio of insulated to bare wire, per unit of length, equals 0.844. When bare copper sells at 15 cents, this insulated wire sells at 20 cents = 22.5 cents on the copper alone, when insulated. If, therefore, we take copper at 25 cents per pound we provide for a very good insulation. The cost of one mil-mile is thus found to be $0.004. Combining this with the familiar formula.

$$C\ M = \frac{16{,}600 \times \text{h. p. transmitted} \times \text{distance in feet.}}{\text{E. M. F. at motor} \times \text{volts lost on line} \times \text{motor efficiency,}}$$

the tabulated values have been determined from the resulting formula:

$$\text{Cost} = \frac{760{,}320}{(E - V)\,V}, \tag{1}$$

in which E = E. M. F. at station, V = volts lost on line; motor efficiency is taken at 90 per cent. and distance at 5,280 feet. The tabular figures give the investment. To reduce to actual cost per horse-power hour, rate of interest and depreciation, and ratio between power transmitted and power possible to be transmitted. For one year the possible horse-power hours = 365 × 24. Take annual interest and depreciation at $\frac{1}{16}$ the investment and ratio of actual to possible power transmitted per annum at 1.0, 0 8, 0.6, 0.4, 0.2, 0.1, 0.05, then the divisor of the tabular number becomes 140.160, 112,128, 84,096, 56,064, 28,032, 14,026 and 7,008 respectively.

It remains to obtain values for the distance of transmission.

Let n = number of miles of line supplied from one station.
h = horse-power required for unit locomotive.
K = maximum number locomotives per mile at any time.

nhK = total power to be transmitted at time of K.
A = percentage of dynamo power lost on line.
$\frac{nhK}{100-A}$ = maximum power to be generated.
$\frac{nhK}{100-A}\times\frac{A}{100}$ = " " lost on line.
b = cost in cents of generating one horse-power hour in station.
r = ratio of average power required to maximum power required.
L = interest and depreciation on supporting structure.

This last may be omitted from the calculation, determining division of line into sections, since it remains the same, whatever that division may be. Omitting this, the expression for cost of transmission becomes:

$$\text{Cost} = \frac{760{,}320\, n^3 h K r}{(E-V)\, V \times 140{,}160} + \frac{b\, n\, h\, K\, A}{r\,(100-A)\, 100}.$$

$$= \frac{5.42\, n^3 h K r}{(E-V)\, V} + \frac{b\, n\, h\, K\, A}{r\,(100-A)\, 100} \qquad (2)$$

Supposing that the time schedule of trains, h. p. required per train, and efficiency of motors be known, and that the initial E. M. F. be in all cases taken as high as the state of the art permits, the only variables remaining in this expression are n, b and A. This latter, the value for the drop on the line, will generally be determined by conditions other than those of strictest economy, as shown by getting a minimum value for cost of transmission We must have a reasonably uniform E. M. F. all along the line, in order that the motors may work satisfactorily. It will not be wide of the mark to assume 10 per cent. as a limiting variation of line potential. This is the figure generally assumed in calculating wire for street railways.

TABLE III.

Total cost of one h. p. hour, in cents.

Output in per cent. of capacity while working.	Hours of work per day.	Capacity of Station.							
		100	300	500	800	1,000	1,500	2,000	3,000
100	24	2.42	1.29	1.06	0.9148	0.860	0.835	0.825	0.816
"	18	2.52	1.36	1.115	0.938	0.868	0.855	0.849	0.829
"	12	2.85	1.52	1.228	1.028	0.955	0.95	0.895	0.867
90	24	2.62	1.36	1.12	0.947	0.88	0.86	0.85	0.83
"	18	2.77	1.45	1.17	0.98	0.91	0.88	0.87	0.853
"	12	3.10	1.61	1.29	1.06	0.99	0.94	0.925	0.89
80	24	2.87	1.45	1.18	0.987	0.92	0.91	0.88	0.86
"	18	3.06	1.55	1.23	1.03	0.98	0.936	0.926	0.90
"	12	3.42	1.73	1.37	1.13	1.06	1.000	0.98	0.95
70	24	3.19	1.57	1.26	1.04	0.96	0.925	0.91	0.89
"	18	3.42	1.68	1.32	1.09	1.01	0.952	0.94	0.91
"	12	3.82	1.90	1.48	1.19	1.09	1.02	1.01	0.97
60	24	3.62	1.73	1.36	1.11	1.01	0.975	0.96	0.94
"	18	3.85	1.85	1.44	1.16	1.06	1.015	1.00	0.965
"	12	4.31	2.11	1.63	1.30	1.17	1.085	1.07	1.015
50	24	4.22	1.95	1.52	1.20	1.10	1.045	1.03	1.00
"	18	4.50	2.10	1.61	1.27	1.15	1.09	1.076	1.039
"	12	5.09	2.40	1.83	1.43	1.28	1.19	1.17	1.114
40	24	5.11	2.28	1.73	1.35	1.21	1.15	1.13	1.10
"	18	5.47	2.48	1.88	1.44	1.33	1.25	1.23	1.17
"	12	5.20	2.82	2.17	1.64	1.50	1.38	1.35	1.28
30	24	6.63	2.84	2.10	1.59	1.40	1.325	1.30	1.26
"	18	7.08	3.02	2.27	1.71	1.51	1.40	1.38	1.32
"	12	8.06	3.52	2.65	1.98	1.73	1.57	1.54	1.44

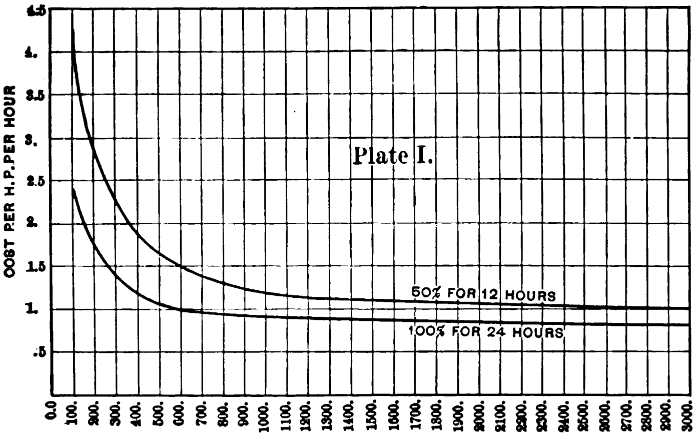

FIG. 1.

The cost of one h. p. hour b must vary with the capacity and conditions of working of the station; hence it is a function of n—*i. e.*, length of unit section, of A, and of that inexpressible variable—the conditions of the service. This stands in the way of obtaining any perfectly general definite expression for n, which, but for this, would result from placing the first differential coefficient of C, with respect to n, equal to zero, and solving to find the value of n, giving a minimum value for C. If trains be run at very short intervals, increase of n would be followed by proportional increase in capacity of station; but, as above shown, this need not go beyond 3,000 h. p. unless the service be so heavy as to require practically contiguous stations of that capacity. If we suppose a case of this short-interval service, so short that a change in n, will not be followed by any change at the station in the relation between maximum capacity and average output, or in the number of working hours, but only in the normal capacity, the relation between b and n for two cases of average output and working hours is shown by Fig. 1. The equation of the 50 per cent. curve from 200 to 1,000 h. p. seems to be very nearly

$$b = \frac{n^2 - 98n + 1{,}000}{12\,(n-100)}.$$

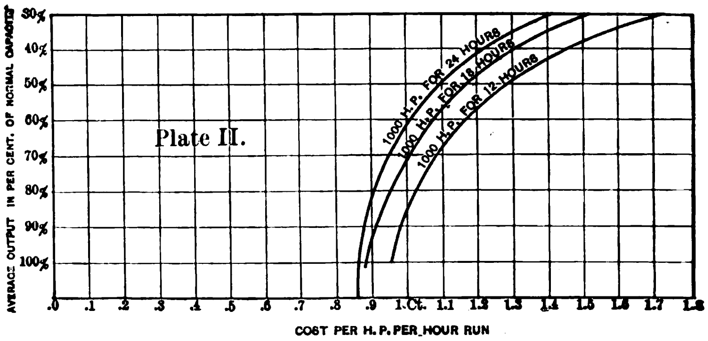

FIG. 2.

If the trains be run at very long intervals, we may require no greater station capacity for 20 than for 10-mile sections; but the relation of output to normal capacity will vary, and possibly the number of hours during which the working force would require to be kept on pay.

Taking the case of a change on average output only, for a 1,000 h. p. station, we have the curves in Fig. 2, for 24, 18 and 12 hours' work. Their equations are nearly of the same form, and are approximately the equations of arcs of circles referred to an origin outside the circle. But each would contain different constants, and would vary more or less from the exact formula for the circle.

If, in the application to a particular case, the algebraic expression for b, above given, or any other resulting from any of the possible progressions through Table III., be substituted in Eq. 2, we may, by differentiation, solve that particular case for the most economical value of n. If the relation between b and n cannot be algebraically expressed, then the proper value for n may be determined by a few trial values, the corresponding values of b being taken from the table.

For the present purposes of comparison, we will assume a case not more favorable than might often be met on busy steam lines, *i. e.*, a station of 2,000 h. p. normal capacity, working 18 hours per day at 40 per cent. of its normal output, the cost per horse-power being 1.25 cents.

To obtain the cost of the line, we will assume that the average distance of transmission is five miles. This would correspond to one station for every twenty miles of road. We will also assume 5,000 volts initial E. M. F. and 10 per cent. drop. From Table IV. the copper investment is found to be 34 cents for one mile. Then for five miles the investment equals $8.50. Making assumptions as to service corresponding to those for the station, we have cost of one horse-power equaling $8.50 ÷ 20,000 = 0.042 cent.

The structure for carrying the conductors may be built for $2,000 per mile. Interest and depreciation would then become $200 per annum. This total is almost wholly independent of the power transmitted, hence the cost per unit of power will vary directly with the number of units transmitted. Assuming a constant distribution of one 500 h. p. train for every 20 miles of line, we have the cost of this item for 1 h. p. hour:

$$20{,}000 \div 365 \times 24 \times 25 = 0.09 \text{ cent.}$$

Reaching the locomotive, we must add, supposing an average output of 500 h. p., 0.08 and 0.06 cent respectively for driver and his assistant. The latter is necessary only as a substitute for his principal in case of emergency, but as such he would doubtless always be placed on trains of considerable value.

Repair on electric locomotives is not as yet well defined. That the repair bill must be far less than in the case of steam locomotives follows almost necessarily from the great reduction in the number of parts, especially of moving parts.

From Mr. Arthur Wellington's very valuable work on railways, I take the figures showing percentage distribution of locomotive repairs, by parts.

Boiler, 20 per cent.; running gear, 20 per cent.; machinery, 30 per cent.; lagging and painting, 12 per cent.; smoke-box, etc., 5 per cent.; tender (running gear, 10 per cent.; body and tank, 3 per cent.) 13 per cent.; total, 100 per cent.

Of these items we may at once, and with certainty, strike out boiler, smoke-box, etc., and tender, thus dropping 38 per cent. of the total. Having no boiler to carry, the running gear will be less in quantity.

The wear will be less, due to the use of rotary instead of reciprocating effort. It will then be fair to reduce this item by half, making another saving of 10 per cent. So in the machinery item, there can be no question that with the rapid advance toward slow-speed motors, reducing gearing, and sounder insulation methods, the great advantage of having only *one moving part* in the motor itself must operate to very largely reduce the repair figure, probably to half its value in a steam locomotive, leaving it at 15 per cent. In lagging and painting, the omission of boiler and other parts must again effect a reduction, say to 6 per cent. The total reduction thus plainly indicated must be then very nearly 70 per cent.

TABLE IV. *For Double Metallic Circuits.*

COPPER INVESTMENT, IN DOLLARS, FOR TRANSMITTING ONE H. P. ONE MILE.
Motor efficiency = 90 per cent.
Initial E. M. F.

Drop on line volts.	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	7,000	8,000	9,000	10,000
100	19.00	8.44	5.42	4.00	3.20	2.60	2.20	1.80	1.60	1.44	1.40	1.28	1.10	0.98	0.84	0.76
200	13.66	4.80	3.42	2.12	1.64	1.34	1.14	1.00	0.88	0.78	0.70	0.64	0.56	0.48	0.42	0.38
300	19.00	3.60	2.12	1.50	1.20	0.94	0.80	0.68	0.60	0.54	0.48	0.44	0.36	0.32	0.28	0.26
400		3.20	1.72	1.20	0.92	0.72	0.60	0.52	0.44	0.40	0.34	0.32	0.28	0.24	0.22	0.20
500		3.00	1.50	1.00	0.76	0.60	0.50	0.40	0 36	0.34	0.30	0.28	0.22	0.20	0.18	0.16
600		3.20	1.40	0.92	0.66	0.54	0.42	0.34	0.32	0.28	0.26	0.22	0.20	0.16	0.15	0.14
700		3.60	1.34	0.82	0.60	0.46	0.38	0.32	0.28	0.24	0.22	0.20	0.16	0.14	0.12	0.10
800		4.80	1.34	0.80	0.56	0.42	0.34	0.30	0.26	0.22	0.20	0.18	0.14	0.14	0.10	0.10
900		8.44	1.40	0.76	0.54	0.40	0.32	0.28	0.22	0.20	0.18	0.16	0.12	0 12	0.10	0.08
1,000			1.50	0.76	0.50	0.36	0.30	0.24	0.20	0.18	0.16	0.15	0.12	0.10	0.08	0.08
1,200			2.12	0.80	0.48	0.34	0.28	0.22	0.18	0.16	0.14	0.12	0.10	0.08	0.08	0.07
1,400			5.42	0.90	0.48	0.33	0.26	0.20	0.18	0.14	0.12	0.10	0.08	0.08	0.06	0.06
1,600				1.12	0.52	0.34	0.24	0.20	0.16	0.14	0.12	0.10	0.08	0.06	0.06	0.056
1,800				2.12	0.60	0.34	0.24	0.18	0.16	0.12	0.10	0.09	0.08	0.06	0.06	0.05
2,000					0.76	0.36	0.24	0.18	0.15	0.12	0.10	0.08	0.06	0.06	0.054	0.046
2.400					3.20	0.52	0.28	0.20	0.14	0.12	0.10	0.08	0.06	0 05	0.048	0.04
2,800						1.34	0.38	0.22	0.16	0.12	0.09	0.08	0.06	0.05	0.04	0.038
3,200							0.78	0.30	0.18	0.12	0.10	0.08	0.06	0.05	0.04	0.034
3,600								0.54	0.22	0.14	0.10	0.08	0.06	0.05	0.04	0.032
4,000									0.36	0.18	0.12	0.08	0.06	0.046	0.038	0.032
4.500										0.60	0.16	0.10	0.06	0.04	0.036	0.030
5.000											0.30	0.15	0.06	0.04	0.038	0.030
6.000													0.12	0.06	0.04	0.032
7.000														0.10	0.054	0.036
8.000															0.08	0.046
9.000																0.008

In using the table it will be convenient to draw curves of equal cost. They will be, roughly, arcs of circles convex toward the left.

The actual cost of repairs to-day on steam locomotives is, on the P. R. R. nearly 0.75 cent per h. p. hour, as will later appear. Reducing as above, this figure becomes 0.22 cent for electric traction. This refers to engines of considerable power; say from 400 to 1,000 h. p. capacity. The figure for both steam and electric motors would go up for smaller powers.

The interest charge results from considering the cost of an electric locomotive as $50 per h. p. and the duty as six hours per day full capacity. The average duty of steam locomotives is only about three hours. The higher figure results from a smaller number of repairs necessary, due to greater simplicity of parts. Then

$$\text{Interest for h. p. hour} = \frac{50.00 \times 0{\cdot}05}{365 \times 6} = 0{\cdot}11 \text{ cent.}$$

Before summarizing we must know something of the efficiency of the system. If the locomotive be of 90 per cent., or 80 per cent., or 60 per cent. efficiency, we must generate, respectively, 1.25, 1.4 and 1.85 h. p. hour in the station for every h. p. hour actually delivered to drivers, line loss being supposed constant at 10 per cent. We should then have in the station 1.56, 1.75 and 2.30 cents, respectively.

TABLE V.

Ratios of cost of motive power.

Efficiency of electric engine.	10 per cent.			20 per cent.			40 per cent.		
Tonnage and area relation.	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8	2 & 3	2 & 5	2 & 8
Speed.									
20	1.15	1.16	1.16	0.92	0.85	0.85	0.56	0.56	0.55
40	1.19	1.19	1.17	0.95	0.95	0.95	0.57	0.57	0.56
60	1.25	1.24	1.19	1.00	1.00	0.95	0.58	0.58	0.56
80	1.33	1.32	1.22	1.07	1.03	0.94	0.50	0.59	0.57
100	1.58	1.42	1.32	1.23	1.20	1.05	0.66	0.65	0.59
120	2.57	1.94	1.47	1.66	1.49	1.13	0.80	0.78	0.64
140	10.03	3.82	1.87	7.35	2.83	1.46	2.72	1.36	0.72

Then, for total:

Station.	1.56	1.75	2.30
Conductor system.......	0.042	0.04	0.04
Structure for same......	0.09	0.09	0.09
Wages....................	0.14	0.14	0.14
Repairs..................	0.22	0.22	0.22
Interest..................	0.11	0.11	0.11
Total.......	2.16	2.35	2.80

Of the whole amount, it is to be noted that the station item is three-fourths. Taking the most favorable case shown by the table,—3,000 h. p. capacity, working for 24 hours at 100 per cent. of capacity—these figures become 1.5, 1.62 and 2.00 cents nearly, the reductions in the other items being still a little indefinite, without making another series of independent assumptions.

The cost of one h. p. hour, excited by steam locomotives, is to be obtained only by some circumlocution, the reports of cost being based on train-mile. As quoted by Wellington, the coal consumed per passenger train-mile on the Pennsylvania Railroad, is very closely 50 pounds, and an average performance will show 5 pounds coal per h. p. hour, while *under way*. This shows that one train-mile equals 10 h. p. hours. The coal consumption for a freight train-mile is much higher, but the divisor would also be higher, on account of the greater number of stops, or at least of backing and switching, and greater delays while on a trip, thus increasing waste of coal.

Again, the Pennsylvania Railroad reports show cost of fuel per train-mile of 5 cents. The cost of coal to that company, as nearly as I can learn, is about $1.50 per ton. Hence it would appear that 66 pounds per train-mile are consumed. As the terminal losses of fuel and delay (getting up steam and drawing fires, etc.), are known to be in the neighborhood of 25 per cent. of the total consumption, we have 6.6 (pounds) as the divisor, and the same ratio again appears.

The cost of one train-mile—as to motor power alone—is given by the Pennsylvania Railroad as 22 cents. And this is practically equal to the average for the United States. The itemized statement is very carefully made up, and seems to cover everything except interest on the engine investment.

Knowing the annual mileage per locomotive to be about 20,000 and the cost to be $10,000, interest charge per train-mile (not quite, but nearly, equivalent to engine mile) becomes 2.7 cents. Total cost becomes 24.7 cents, or 2.47 cents per h. p. hour, efficiency being constant at 100 per cent.

We may safely use this figure in the comparison to be made, since any positive error in the calculation of coal per h. p. hour, or negative error in h. p. hours per train-mile, will be offset by the difference in cost of coal per ton to the P. R. R. as compared with the value assumed in Table III.

At $3, instead of $1.50, the full item would be 10 cents and the total motive power 29.5 cents. Leaving the statistics of actual cost, we may reach, by the method of Table III., nearly the same figure, considering the locomotive as a 1,000 h. p. steam plant, of low first cost, burning 6 lbs. of coal per h. p. hour, and working at one-third capacity for about three hours per day. The result thus reached is about 10 per cent. higher, but the 2.47 cents seems most reliable.

These values multiplied into the corresponding values in the last nine columns of Table I., give the following values of:

$$\frac{\text{Power units, steam}}{\text{Power units, electric}} \times \frac{\text{cost per unit, steam.}}{\text{cost per unit, electric.}}$$

This value, Table V., being greater than unity indicates greater economy by electricity than by steam, and vice versa.

A glance at the table shows the dominating necessity of increasing the efficiency of the mechanism delivering energy from the electric line to the vehicle. We cannot count upon a higher efficiency than 90 per cent. for the motor. Hence, save in the case of putting the armature directly on the axle, we cannot hope to reduce the total loss to less than 20 per cent.—a case permitting one set (*i. e.*, two gears) of spur gearing between armature and axle. As the ordinary relation between tonnage and resisting area will lie between the second and third columns of each efficiency table, it appears that with a 20 per cent. loss electricity becomes cheaper than steam at about 70 miles per hour.

In the case of 40 per cent. loss our new agent betters the old only at 140 miles per hour. And yet this loss—40 per cent.—is about the best we do with our present systems of electric propulsion. This appears from the following tabulation of results obtained by me on the Brooklyn & Jamaica Electric Railway, Table VI.

Considering the very short life of the art, these results are excellent. Indeed, excellence is shown in the mere fact of success in competing with horses under conditions very trying for any mechanism not made of india-rubber or whit-leather. How great that success has been I need not here proclaim. But the steam locomotive is a foeman more worthy of our steel, or rather of our annealed soft iron, and 99 per cent. copper.

Consideration of all that precedes leads to the following general conclusions:

1. A slow-speed armature placed on the car axle would place the electric motor in the lead at all service speeds.

2. For speeds above 70 miles per hour an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency would prove more economical than the steam locomotive—save in cases of very infrequent service on very long lines.

3. On lines for heavy traffic steam would be more economical than electricity if motor and gearing have a combined efficiency as low as 60 per cent., up to 100 miles per hour.

4. At speeds of 100 miles per hour and upward, neither steam at 90 per cent. nor electric apparatus at 60 per cent. efficiency is commercially practicable.

5. Inasmuch as the saving of coal in stationary, as compared with locomotive engines, is one of the chief causes of the greater economy of electric propulsion, at any speed, this advantage will increase with that difference and also with the price of coal.

6. Any cause other than inefficiency of motor which increases the power required to haul a ton of freight, increases the advantages of electricity, since it enlarges the value of the coal difference and the dead-weight difference.

Thus bad roadways and large areas exposed to atmospheric resistance, as in street railway work, lower the speed at which electric motors of any efficiency become cheaper than steam.

7. In descending to small locomotive units, the electric motor loses less, relatively, of its advantage—another reason for success on street lines.

8. Multiplying the number of motors should be, as far as possible, avoided.

9. In special cases cleanliness and compactness of electric machinery may be of great value; in case of very frequent stops, the possibility of returning to the line the energy now wasted in brakes may be of considerable value. This, however, can be obtained only by sacrifice in the matter of dead-weight, as normal working is implied to be at comparatively low magnetization. Loss due to low efficiency in starting can scarcely be avoided either in steam or electric engines.

10. Other minor pros and cons may be enumerated, but I believe that in considering the general economic results of the two systems we reach more definite conclusions.

While only one condition of station working has been taken for final comparison, that case is an average one, and comparative results would be but slightly affected by ordinary variations. Extreme cases may be readily determined from the tables and formulas presented.

11. Some differences of opinion as to the proper values for the various constants are to be expected, but I believe these differences, taken all along the line, would nearly balance between positives and negatives, leaving the general results and the method unchanged.

THE NATIONAL WATER WORKS ASSOCIATION held their convention in Chicago at the Grand Pacific Hotel, May 20, 21, 22. The electric light companies subscribed very liberally to a fund for the entertainment of the association.

TABLE VI.

Figures on street-car traction. Track nearly level.

Date.	Designation of motor-car.	Weight of motor-car and passengers.	Weight of towed car and passengers.	Length of trip in miles.	Average speed, miles per hour.	Potential at station. volts.	Ditto at car, average.	Current in motor "A." amperes.	Current in motor "B."	Current in trolley wire of car.	Difference of "A" and "B."	Number of readings averaged.	Corresponding time interval, seconds.	Total average energy in car, in h. p.	Horizontal effort req'd per ton, in pounds.	Corresponding mechanical h. p.	Hysteresis, eddy currents and friction in armature "A," watts.	Ditto in armature "B."	$C^2 R$ loss in "A," watts.	Ditto in "B."	Total loss in motor or motors, h. p.	Total gearing loss, h. p.	Efficiency of motor or motors.	Ditto of gearing, one or two sets.	Ditto of motors and gearing.	Record number of run.	Remarks.
April 3	No. 6	Pounds 12,000	0	3.5 and return, 7.0	9.3	480	440	6.63	6.63	13.27	A and B assumed equal except when difference was measured.	262	10	7.63	27.5	4.09	550	550	88	88	1.71	1.83	77.4	69.0	53.6	1	Track this day rather dirty. Tonnage coefficient taken 10% higher than April 20, when observations were made.
3	6	12,000	0	2.84 and return, 5.78	10.45	480	440	7.6	7.6	15.2		185	10	8.92	27.5	4.6	600	600	115	115	1.97	2.4	78.0	65.7	51.5	2	
3	8	12,000	0	2.84 and return, 5.78	11.5	480	440	11.85	0	11.85		145	12	6.96	27.5	5.06	675	0	230	0	1.2	0.7	82.7	87.8	72.7	3	Armature of motor "B" taken out for this and trip No. 4.
3	8	12,000	0	3.5 and return, 7.0	9.1	480	440	10.0	0	10.0		230	12	5.87	27.5	4.0	550	0	200	0	1.0	0.87	83.1	82.1	68.0	4	
20	8	11,850	6050	2.84 and return, 5.78	10.0	480	440	7.85	7.85	15.7		144	15	9.25	25	6.0	600	600	123	123	1.94	1.31	79.0	82.0	64.8	5	Dynamometer between motor and tow car. 131 readings taken.
20	8	12,000	7200	2.84	8.3	480	440	12.26	0	12.26		85	15	7.23	25	5.31	500	0	300	0	1.07	0.85	85.2	86.0	73.0	6	Motor "B" cut out of circuit.
May 2	8	12,400		2.84 and 3.5 6.34	10.9	480	440	7.68	5.52	14.2	1.16	131	15	8.37	25	4.5	650	650	116	61	1.98	1.89	76.3	70.4	53.7	7	Separate ammeter in each motor circuit and in main.

NOTE.—Voltmeter readings taken April 3, and 20, assumed same values May 2. Traction coefficient also taken from April 20, as track was in same condition. Losses in motors cannot be given with perfect accuracy, as they have not been determined for wide ranges of condition by shop tests. Values for hysteresis, etc., here taken correspond closely with several shop tests. Except $C^2 R$, motor loss does not vary largely with current flowing in practice, as with a low current, a very large armature induction is effected. The "R" in $C^2 R$ cannot be known accurately, as it constantly changes with change in position of switch. A fair average of switch position was obtained from observation. Total error in motor losses probably not greater than 10 per cent. Run No. 7 not introduced here for discussion of difference of action of motors "A" and "B:"

Average efficiency whole mechanism, two motors = 55.9 per cent.
" " " " one motor = 71.2 "
" " one motor alone............... = 83.6 "
" " two motors " .... = 77.6 "
" " two sets gears alone....... .. = 71.8 "
" " one set gears................... = 85.3 "

LIFE AND EFFICIENCY OF ARC LIGHT CARBONS.[1]

BY LOUIS B. MARKS, M. E.

From the experimental stage of arc lighting to the commercial application of the system to-day, little or no increase in the efficiency of the carbon points appears to have been made.

Now that our dynamos and lamps have reached such a state of perfection, the subject presents itself as pre-eminently important. The arc light pencil, considered as an individual part of the plant, is indeed a small thing, but in it undoubtedly lies the weak spot of the system.

It was with a view of studying the action of modern carbon pencils, that the investigations here to be described were undertaken. The carbons experimented upon were all of American manufacture, and were procured from five companies, (A, B, C, D and E)

While the greater part of the research was upon the life and efficiency of the pencils, observations were also made in other directions.

The subject will be treated under the following heads:—

1st. Structure of the carbons.
2d. Life tests.
3d. Efficiencies.
4th. Candle-power measurements.
5th. Observations of the arc and carbon points.

It is well known that the life and efficiency of a carbon depends upon the system in which the latter is burned. For instance, "the requirement of the low tension system seems to be a carbon that is hard, well plated and a good conductor, the latter being the most important."

"In the high tension system, on the contrary, hardness and conductivity seem to be of secondary importance. There is a tendency to 'flame' and burn unsteadily when a hard carbon is used in this system, and a softer one sometimes becomes necessary.[2]"

It is interesting to note the methods employed by carbon manufacturers to attain the conditions above mentioned. In one of our largest carbon works, "forced" carbons, or those made by "squirting" the plastic material through a die, are manufactured for both high and low tension systems of lighting, to the exclusion of molded pencils. On the other hand, another company makes no forced carbons, but claims that its molded pencils are superior for either system. From the classification given below, can be seen the types of carbons now upon the market for both systems.

One of the first things that suggested itself was the study of the structure of the various samples submitted.

Carbon.	High tension.	Low tension.
A	molded	forced
B	"	molded
C	"	"
D	forced	forced
E	molded forced	"

For this purpose, thin transverse sections of all the specimens were cut and mounted on glass slides, and a microscopical examination made.

The accompanying photographs (Figs. 1–12) show the appearance of the carbons under a magnifying power of about forty diameters in the case of groups A, B and C, and about eighty diameters in that of D and E. While the views cannot give either the color or lustre of the original, they are mainly useful in con-

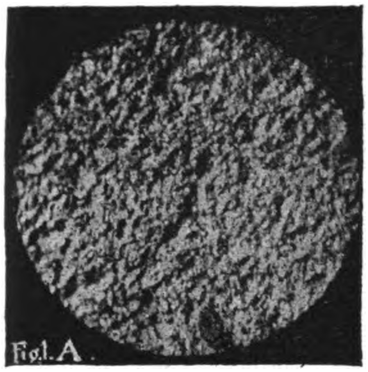
Fig. 1. A.

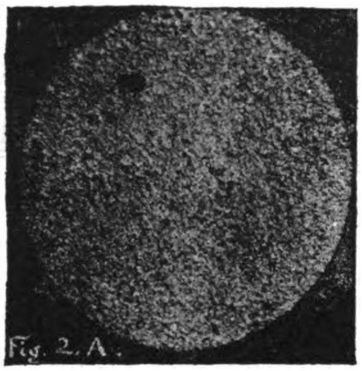
Fig. 2. A.

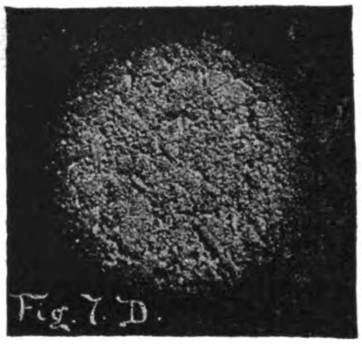
Fig. 7. D.

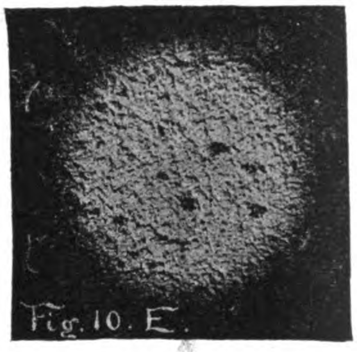
Fig. 10. E.

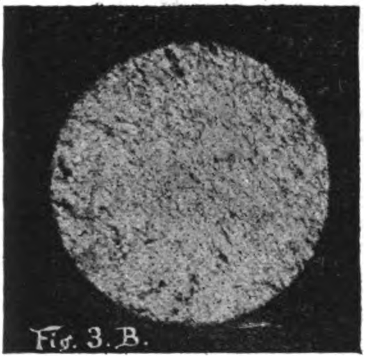
Fig. 3. B.

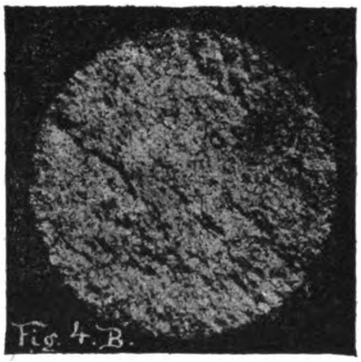
Fig. 4. B.

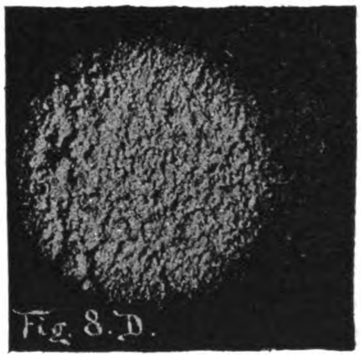
Fig. 8. D.

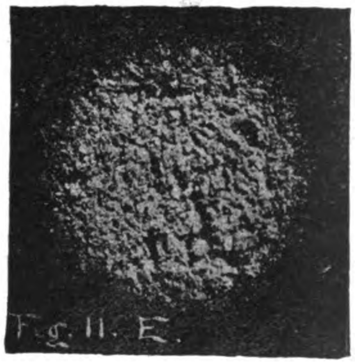
Fig. 11. E.

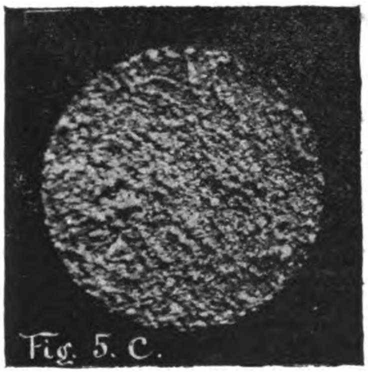
Fig. 5. C.

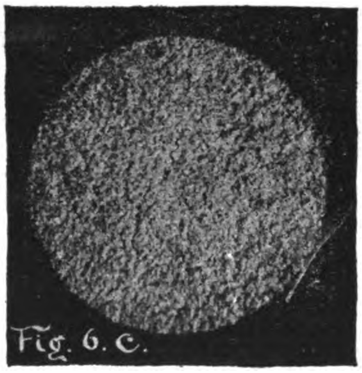
Fig. 6. C.

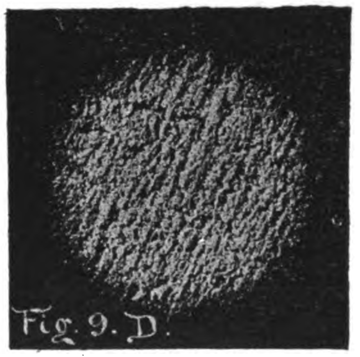
Fig. 9. D.

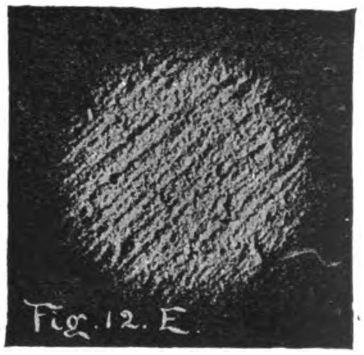
Fig. 12. E.

Arc Light Carbons Under the Microscope.

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[1] Read before the General Meeting of the American Institute of Electrical Engineers, Boston, May 21st, 1890.

[2] G. W. Parker: Proceedings National Elec. Light Assoc'n, Pittsburgh Convention, Feb., 1888, p. 455.

veying an idea of the texture of the surface.

Examining the photographs, we note that there is a marked difference between the structure of a molded and a forced carbon. In the high tension pencil of the brand A, (Fig. 1) the structure is a loose one, while the low tension rod of the same group is marked by a dense homogeneous structure; the size of the grains of carbon in the latter case is very much less than in the former, and as seen under the magnifying power of the microscope, the particles have a more metalloid lustre. Again there is probably considerable air space in Fig. 1.

Thus it appears that Fig. 1 has the qualifications of a high tension carbon, *i. e.* looseness of structure, hence comparative softness and high resistance; and Fig. 2 the requisites of a low tension pencil, *i. e.* density, hardness and low resistance. The resistance of the rod (Fig. 1) was measured and found equal to .199 ohm; that of Fig. 2 equalled .144 ohm. The resistance of the plated low tension carbon was .084 ohm.

The structure of the carbons in group B (Figs. 3 and 4) was found after close examination to be about the same. To secure the requisite low resistance of Fig. 4 the pencil was heavily copper-plated, the thickness of the coating being about 1-10 millimetre, while that of Fig. 3 was a little less than 1-20 millimetre.

A method different than either of those just described is used in the manufacture of carbons C, (Figs. 5 and 6.) As in the previous instance, molded carbons are made by this company for both high and low tension systems, but a much greater pressure is applied to the molds in manufacturing low tension pencils than in the case of high. This accounts for the difference in structure exhibited in the photographs; although a molded carbon, Fig. 6 thus approaches the structure of the forced pencil, Fig. 2.

Groups D and E are highly magnified. An attempt has been made to manufacture a carbon that will burn fairly well in either system. Fig. 8 shows this carbon. In structure it is a mean between Fig. 7 and Fig. 9. Besides a difference in pressure used in constructing pencils of group D, there is also a difference in the "mix" or composition of the carbon.

The dissimilarity in structure between carbon E, Fig. 11 and E, Fig. 12 is apparent, yet both pencils are used in high tension systems. The efficiency of these types, as well as of the others will be discussed later. Fig. 12, it will be noted, is very similar in structure to Fig. 9 (carbon D); in both cases the striations are marked and indicate that the carbon is built up of strata lying longitudinally, or in the same direction as the application of the pressure used in manufacturing the pencils. When examined with the microscope, carbon D, (Fig. 9) evinced more lustre than Fig. 12, showing that a greater quantity of pure carbon was used in the manufacture of the former.

LIFE TESTS.

If a carbon is burned with a small current its life will be long at a sacrifice of light-giving properties. If on the other hand a large current is used, there may be a gain in efficiency at a sacrifice of life. The question arises—what is the proper current to use? Of course circumstances determine to a large extent the answer and generally such a current is used as gives a fair mortality at a reasonable efficiency of the carbon.

The high tension carbons submitted for test were designed to be burned at about 10 amperes and the low tension at about 20. In the life tests a Thomson lamp was used for high tension runs, current being kept constant at 10 amperes and P. D. at 50 volts. For low tension carbons the Weston lamp was used. The pencils were accurately weighed before and after the runs, and the life calculated on the assumption that the carbons were homogeneous. Each set of pencils were burned an hour. The results of tests are given in Table 1.

TABLE 1.

Life Tests.

CARBON.	Mean diameter; inches.	Resis. ohms.	Initial wt. + grms.	Initial wt. — grms.	C. amperes.	P. D. volts.	Loss in wt. + grms.	Loss wt. — grms.	Life 12 inch + carbon hours.
A molded high ten. (naked)..	.502	.199	59.87	25.10	10.	50	5.86	3.59	10.22
A forced low ten. (plated)...	.500	.072	64 89	27.16	21.5	30	6.15	4.43	10.55
B molded high ten. (plated)..	.506	.075	58.17	28.32	10.	50	4.80	2.44	12.12
B molded low ten. (plated)..	.498	.071	367.80	295.50	22.5	28	106.60	51.50	9.42[3]
C molded high ten. (naked)..	.510	.2165	62.94	29.03	10.	50	6.21	3.63	10.13
C molded low ten. (plated)..	.515	.0715	594.40	294.50	22.5	28	151.00	41.0	9.83[3]
D forced low ten. (plated)....	.506	.095	62.46	36.10	21.5	30	6.92	3.08	9.03
D forced high or low ten. (plated)	.504	.142	60.58	29.78	10.	50	6.65	4.16	9.11
D forced high ten. (naked)..	.457	.187	47.20	23.53	10.	50	5.46	3.29	8.64
E forced low ten. (naked)....	.505	.2207	344.68	244.64	22.5	28	193.18	74.42	7.71[3]
E molded high ten. (naked)..	.533	.202	63.30	30.48	10.	50	6.09	3.04	10.39
E forced low ten. (naked)....	.522	.251	59.62	29.81	10.	50	5.91	3.52	10.09

It has been stated that "with carbons of the same *hardness* and length but having different diameters, the larger will undoubtedly outlive the smaller. Of carbons of the same *diameter* and length, but differing in hardness, the harder will outlive the softer."[4]

This statement presupposes that the conductivity of the carbon is directly dependent on the hardness or softness of the pencil.

In order to examine more fully the relation between diameter, resistance and mortality of a pencil, six sets of carbons of the brand B., varying in diameter from ½ to 1¼ inch were carefully weighed, their resistances measured by the Wheatstone bridge method and the pencils burned with a constant current of 10 amperes from a Gramme dynamo, the P. D. at the terminals of the lamp being kept at 50 volts. The diameters and resistances respectively of the upper and lower carbons were in each case practically the same. A mean of 10 micrometer measurements of the diameter, was taken as correct. The duration of each run was 60 minutes.

Following are the data:—

TABLE 2.

Mortality with Different Diameters.

CARBON.	Mean diameter; inches.	Resis. ohms.	Initial wt. + grms.	Loss wt. + grms.	Life 12 inch + carbon hours.
B molded high ten.	.453	.0805	44.70	4.20	10.64
" "	.505	.075	58.17	4.80	12.12
" "	.618	.0735	94.93	6.96	13.64
" "	.739	.0615	182.34	6.19	21.88
" "	.986	.061	282.20	8.88	26.15
" "	1.195	.059	339.57	10.14	33.49

From the results given in Table 2, it appears that the life of a carbon varies *directly* with its *diameter* and *inversely* with its *resistance*. This law holds only for homogeneous carbons of the same manufacture, type and structure, and as stated before, for constant current and voltage.

Let us take the ½ inch (.505") and 1 inch (.986") pencils as standards and from the relation above stated, calculate the mortality of the other carbons.

Table 3, gives a comparison of the actual and the calculated life of the various specimens tested.

TABLE 3.

CARBON.	Mean Diam. inches.	Standard ½" (505")	Standard 1" (.986")	Actual life hours.
		Calculated life hours.	Calculated life hours.	
B molded light.	.453	10.92	9.33	10.64
" "	.618	15.10	13.62	13.64
" "	.739	21.58	19.44	21.88
" "	1.195	36.40	33.04	33.49

Thus it appears that the calculated life throughout the series is larger than the actual when the ½" carbon is taken as a standard and smaller when the 1" pencil is made the basis of calculation.

The carbons of group B were not perfectly round, a variation of 3% being at times found, between the 10 measurements of the diameter of a pencil. In determining the resistance of the carbon rods, the tips of the latter were copper-plated when necessary and mercurial contacts used. The lamp was adjusted to burn at 50 volts potential difference for each set of pencils.

While every precaution was taken to avoid discrepancies, it is clear that from the nature of the substance experimented upon, and the extreme difficulty of maintaining constant conditions, errors are apt to creep into the work. But the results given in Table 3, as well as later determinations undoubtedly point to the existence of such a law as has been quoted.

The relation between diameter and life having been investigated, experiments were then made to determine the curve for current and mortality of the pencil, when the voltage is kept constant.

For this purpose a number of molded high tension carbons of the brand E were used. To secure uniformity in the plus and minus pencils, a 12 inch stick was broken in half, one portion being used as the upper, the other as the lower carbon. The length of each run was an hour. Current and potential were read every two minutes and the mean taken.

Table 4 gives the data from which the curve for current and mortality (Fig. 3) was plotted.

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[3] These low tension runs were made with the Weston plant on the University Campus. Ten lamps were run in series. Time of test was 2¼ hours in the case of carbons B and E, and 2 hours and 25 min. in the case of C.

[4] G. W. Parker.

TABLE 4.

Life with Different Currents and Constant Potential.

CARBON.	Diam. mean inches.	Resis. ohms.	Initial wt.+ grms.	Initial wt.— grms.	C. amp.	P. D. volts.	Loss wt.+ grms.	Loss wt.— grms.	Life per inch. Carbon burned hours.	$\left\{\frac{\text{Life}-}{\text{Life}+}\right\}$
E molded high ten.	.518	.199	30 20	21.15	6.02	49.3	4.48	2.76	.6723	1.62
" "	"	"	25.72	18.38	7.04	49.7	4.87	3.19	.6047	1.54
" "	"	"	20.85	15.19	8.01	49.9	5.42	3.25	.5622	1.66
" "	"	"	37.56	24.16	8.99	49.9	5.81	3.63	.5450	1.60
" "	"	"	31.75	20.53	10.01	49.3	6.16	3.98	.5072	1.52
" "	"	"	30.52	21.72	11.00	50.2	6.67	4.18	.4910	1.60
" "	"	"	34.30	26.90	12.03	50.3	6.65	4.35	.4637	1.52
" "	"	"	37.78	26 33	13.00	50.1	7.[illegible]6	4.61	.4502	1.57

As will be seen the range of current was from 6 to 13 amperes. The greatest variation of the mean E. M. F. for the several runs was one volt.

TABLE 5.

Life with Different Potentials and Constant Current.

CARBON.	Mean Diam.; inches. +	Mean Diam.; inches. —	Resis. ohms.	Initial wt.+ grms.	Initial wt.— grms.	C. amperes.	P. D. volts.	Loss wt.+ grms.	Loss wt.— grms.	Life per inch. Carbon burned hours.	$\left\{\frac{\text{Life}-}{\text{Life}+}\right\}$
E molded high ten.	.518	.513	.199	51.58	48.32	10	40	5.625	2.32	.6425	2.344
" "	.521	.517	.197	37.65	24.16	10	45	5.605	2.87	.6077	1.958
" "	.531	.522	.185	24.86	19.06	10	50	5.83	3.49	.5453	1.693
" "	.531	.522	.185	24.86	19.06	10	55	6.34	4.025	.4903	1.589
" "	.527	.530	.191	23.52	19.34	10	60	6.70	4.41	.4525	1.484

A series of tests was now made with constant current and varying voltage. The current in this case was maintained at ten amperes, and the range in tension was from forty to sixty volts. Carbons of the same type as in the last instance were used. In Table 5, are given the figures for these runs, and Fig. 14 shows the curve for voltage and mortality.

In the curves (Figs. 13 and 14) the ordinates represent the life of an inch of carbon in minutes. Reference is made not to the mortality of the plus pencil, but to the total amount of carbon burned in the lamp. The last two columns in Table 5, have been corrected for diameter and resistance of the pencil, the diameter and resistance respectively of the carbon that was burned at 10 amperes and 45 volts having been taken as a standard, and the life of the other pencils reduced to a common basis from this, according to the law previously stated.

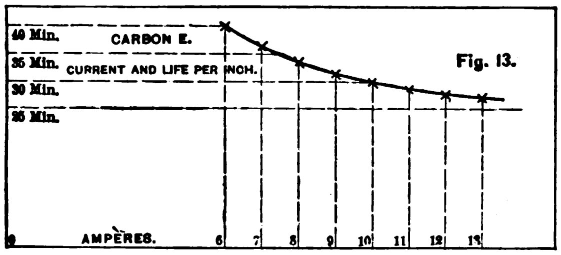

FIG. 13.

Very little has been published regarding the relative life of the plus and minus carbons. Those books in which the subject is alluded to, state as a rule that with direct currents, the life of the upper carbon is about half that of the lower, provided both have the same length originally. In a recent publication[5] the general statement is made that "with continuous currents the plus wastes twice as fast as the minus carbon. With alternating currents the upper wastes 8 per cent. faster than the lower if the carbons are vertical; but at the same rate if horizontal."

TABLE 6.

Relative Life of the Plus and Minus Carbons.

CARBON.	Initial wt.+ grms.	Initial wt.— grms.	C. ampere.	P.D. volts.	Length run; minutes.	Loss wt.+ grms.	Loss wt.— grms.	$\left\{\frac{\text{Life 1''}-}{\text{Life 1''}+}\right\}$
B molded high ten.......	48.38	25.22	10	50	60	5.28	4.40	1.20
B " low ten........	61.43	31.87	10	50	60	5.14	3.27	1.57
A " high ten.......	90.57	38.68	10	50	60	5.98	3.20	1 87
10 E forced low ten......	344.68	244.64	22½	28	150	193.18	74.42	2.59
10 B molded low ten. ..	367.80	259.50	22½	28	150	166.60	51.50	3.23
10 C " "	591.10	294 50	22½	28	145	151.00	41.00	3.68

No experiments were made upon arc-light carbons fed by alternating currents but an investigation of the relative loss of the plus and minus pencils with direct currents gave quite interesting results. Table 6 shows that the plus carbon may burn away about as fast as the minus, or may waste more than three and a half times as quickly.

Three sets of experiments were undertaken to determine the elements that effect this ratio.

FIRST. Effect of changing the diameter and resistance of the pencils with constant current and potential.

SECOND. Influence of change of current with constant potential.

THIRD. Change of potential with constant current.

For determining the influence of diameter and resistance upon the relative life of the plus and minus carbons, a number of molded high tention pencils of the brand A were used. The carbons were supposed to have been taken from the same "batch" and were burned with a current of 10 amperes and a P. D.=50 volts.

Examining Table 7, which gives the results of measurements we note that $\left\{\frac{\text{life}-}{\text{life}+}\right\}$ appears to become greater with increase of diameter of the carbon. It is probable that the inequality in the diameters of the + and — pencils respectively, as well as the difference in the resistances of the two carbons of a set explains to a large extent the cause of this increase in the ratio. For, assuming that under the conditions maintained, the life of a carbon varies directly with its diameter and inversely with its resistance, the data, (Table 7), indicate that if the diameters and resistances, respectively, of the + and — carbons were the same in each run, the ratio would be practically the same for all sizes of carbons. This is brought out in the last column of the table, which gives the corrected values of $\left\{\frac{\text{life}-}{\text{life}+}\right\}$.

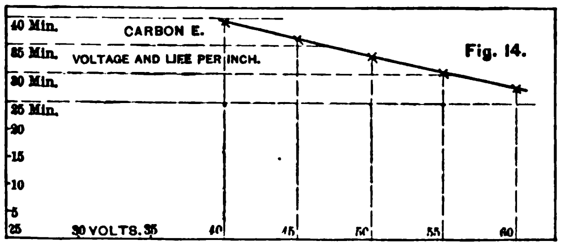

FIG. 14.

SECOND. Reference to the last column of Table 4 will show that a change in the current, other conditions remaining the same, probably has no effect on the ratio $\left\{\frac{\text{life}-}{\text{life}+}\right\}$. For when a current of 6 amperes was used, the ratio was equal to 1.62; at 7 amperes the ratio dropped to 1.54; it then alternately increased and decreased to thirteen amperes. Hence it may be said that if all errors of observation, as well as those due to irregularities in the carbons could be eliminated, the $\frac{\text{life}-\text{carbon}}{\text{life}+\text{carbon}}$ would be found to be constant.

TABLE 7.

Influence of Diameter and Resistance of the Carbon upon the Relative Life of the + and — Pencils.

CARBON.	Mean diam. inches. +	Mean diam. inches. —	Resis. ohms. +	Resis. ohms. —	Initial wt. +	Initial wt. —	Loss wt. +	Loss wt. —	$\left\{\frac{\text{Life 1''}-}{\text{Life 1''}+}\right\}$	$\frac{\text{Life 1''}-}{\text{Life 1''}+}$ corrected.
A, molded high ten.	.3964	.4 83	.255	.24	37.91	16.97	4 96	3.04	1.63	1.79
"	.4567	.4567	.225	.243	48.98	20.26	5.41	3.2	1.65	1.78
"	.5018	.5153	.199	.207	59.87	25.10	5.86	3.59	1.63	1.74
"	.5698	.5622	.178	.120	69.83	26.91	6.23	3.61	1.73	1.81
"	.6311	.6263	.152	.149	90.57	38.68	5.98	3.20	1.87	1 83

THIRD. The last column of Table 5 contains the data for $\frac{\text{life}-}{\text{life}+}$ with different P. D.'s and constant current. From these calculations it appears that the ratio depends on the P. D. and that the greater the P. D., the more nearly does the former approach unity. The curve plotted from the figures in Table 5, is given in Fig. 15, the abscissæ being volts, and the ordinates representing the ratio of the life of the minus to the life of the plus carbon.

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[5] Munro & Jamieson's Electrical Rules and Tables, 1889.

Thus the causes that influence the relative life of pencils of the same diameter, lie chiefly in the difference in the resistance of the carbons and the variations of P. D.

Judging from existing theories of the arc, it was thought that blowing the latter with a magnet during the runs would relatively increase the life of the plus carbon. The experiment was tried and the reverse was found to take place, *i. e*, the ratio $\left\{\frac{\text{life}-}{\text{life}+}\right\}$ increased while the life of the minus pencil was not much affected.

EFFICIENCIES.

Two methods of determining the efficiency of each set of pencils were employed. The first was the method used by Mr. Merritt in obtaining the efficiency of the incandescent lamp[6] and subsequently by Mr. Nakano in his work on the efficiency of the arc-lamp[7]. The second dealt with candle-powers and will be referred to in the discussion of candle-power measurements.

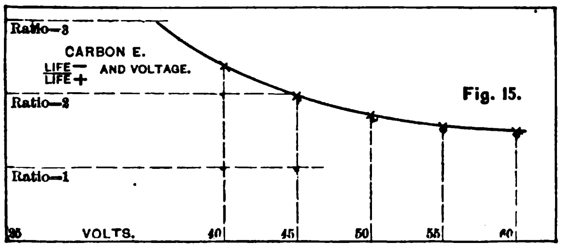

FIG. 15.

It may not be amiss to give here an outline of the first method employed. A Thomson lamp was mounted on a movable frame and the rays from the burning carbons allowed to fall on the face of a thermo-pile, the latter being in circuit with a sensitive Thomson galvanometer. The deflection of the galvanometer was taken as a measure of the energy of the total radiation which fell upon the face of the pile. A cell containing a solution of alum was then interposed between the light and the pile, and the reduced deflection of the galvanometer noted. On the supposition that the alum cell cut off all the "dark heat" and allowed only the rays of the visible spectrum to reach the face of the thermo-pile, the last measurement would give the true value of the luminous energy emitted by the lamp. But a small percentage of the longer wave lengths passes through the alum cell, and a large part of the luminous rays is cut off by its intervention. Corrections having been made for these factors, the true values of luminous radiation resulted.

A mechanism was provided by which measurements could be made at various angles below the horizontal plane without altering the distance between the center of the arc and the thermo-pile.

For the high tension runs, the lamp was fed by a current of 9 amperes, the potential difference between its terminals being kept at 45 volts. For low tension tests, current=21½ amperes, and P. D.=30 volts. Note that the amount of energy expended in the low tension lamp was 21½ × 30 = 645 watts, while the high tension required but 9 × 45 = 405 watts. Although normally the former requires from 520 to 560 watts, unsteadiness of the light when the lamp was run below 21½ amperes made accurate measurements impossible.

Tables 8—15 give the results of efficiency tests. In the column headed (L) are given the corrected values of deflections due to luminous radiation; the values of (T) refer to total radiation and the efficiency or luminous divided by total radiation $= \left\{\frac{L}{T}\right\}$.

These tables furnish the data from which the curves (Figs. 16-23 were plotted. The radii show the positions for which measurements were taken, and distances measured along these lines from the origin to the *dotted* curves give the intensity of luminous and total radiation, respectively in each position.

It will be seen that the distribution of total radiation differs considerably from that of luminous radiation, hence the efficency, which is expressed by $\left\{\frac{\text{luminous radiation}}{\text{total radiation}}\right\}$ depends upon the angle of measurement.

The full-line curves (Figs. 16-23) represent the efficiencies of the various carbons. In order to obtain the mean or hemispherical efficiency, the areas of the curves of luminous and of total radiation were found by means of the planimeter; now the ratio of the radii of two semi-circles whose areas are respectively equal to those of the curves of luminous and total radiation, is the value of the mean spherical efficiency. This value has been calculated for each set of pencils and the results are given in Table 16; also in Figs. 16-23.

EFFICIENCY MEASUREMENTS.

TABLE 8.

Carbon A. Molded High Tension.

Angle.	L	T	$\frac{L}{T}$
0°	6.085	110	.0553
10°	8.112	130	.0624
20°	11.49	134	.0858
30°	16.99	146	.1158
40°	23.67	146	.1621
50°	15.55	143	.1087
60°	10 14	125	.0811

TABLE 9.

Carbon D. Forced High Tension.

Angle.	L	T	$\frac{L}{T}$
0°	4.733	107	.0442
10°	8 133	118	.0688
20°	11.49	129	.0891
30°	14.20	142	.0977
40°	16 91	152	.1112
50°	19 61	156	.1257
60°	8.790	142	.0619

TABLE 10.

Carbon B. Unplated Molded High Ten.

Angle.	L	T	$\frac{L}{T}$
0°	10.14	114	.0889
10°	13.52	127	.1065
20°	15.55	144	.1080
30°	18.26	157	.1163
40°	22.31	165	.1352
50°	22.31	163	.1352
60°	15.55	156	.0995

TABLE 11.

Carbon B. Plated Molded High Ten.

Angle.	L	T	$\frac{L}{T}$
0°	11.49	116	.0991
10°	14.21	128	.1057
20°	15.55	145	.1072
30°	19.60	157	.1248
40°	22.31	164	.1361
50°	18.93	164	.1369
60°	15.55	141	.1103

TABLE 12.

Carbon E. Molded High Tension.

Angle.	L	T	$\frac{L}{T}$
0°	2.702	116	.0233
10°	5.405	134	.0403
20°	8.108	146	.0555
30°	13.51	157	.0861
40°	17.57	159	.1105
50°	11.48	145	.0792
60°	7.77	112	.0710

TABLE 13.

Carbon E. Forced High Tension

Angle.	L	T	$\frac{L}{T}$
0°	2.702	118.5	.0228
10°	4.054	131.0	.0310
20°	6.756	158.	.0428
30°	6.081	——	.0483
40°	10.13	175.0	.0579
50°	14.19	155.0	.0895
60°	11.48	136.0	.0844

TABLE 14.

Carbon A. Forced Low Tension.

Angle.	L	T	$\frac{L}{T}$
0°	8.784	162	.0542
10°	12 16	170	.0715
20°	20.27	185	.1095
30°	25.68	190	.1351
40°	25.68	190	.1351
50°	16 89	157	.1080
60°	9.459	130	.0728

TABLE 15.

Carbon B. Molded Low Tension.

Angle.	L	T	$\frac{L}{T}$
0°	10.81	190	.0569
10°	17.57	211	.0833
20°	25.68	223	.1151
30°	28.38	223	.1273
40°	17.57	215	.0817
50°	12.33	182	.0678
60°	6.081	135	.0451

TABLE 16.

Efficiency Measurements.

CARBON.	Diam. mean inches.	Resis. ohms.	C. amp.	P. D. volts.	Horizontal efficiency.	Maximum efficiency.	Hemispherical efficiency.	Life 12 inch + carbon hours.	$\frac{C.}{P. D.}$
A molded high ten...........	.508	.203	9	45	.0553	.1621	.1171	10.22	(10-50)
D forced high ten.........	.457	.187	9	45	.0442	.1257	.1001	8.64	(10-50)
B molded (unplated) high ten	.453	.224	9	45	.0889	.1352	.1369	9.16	(10-50)
B molded (plated) high ten..	.453	.0805	9	45	.0991	.1369	.1372	10.64	(10-50)
E molded high ten,..........	.533	.202	9	45	.0233	.1105	.0896	10.39	(10-50)
E forced high ten...........	.522	.251	9	45	.0228	.0895	.0776	10.09	(10-50)
A forced low ten.............	.500	.072	21.5	30	.0542	.1351	.1105	10.85	[illegible]
B molded low ten............	.498	.071	21.5	30	.0569	.1273	.0932	9.43	[illegible]

We notice that the horizontal efficiency is very small compared with the maximum; that relatively high efficiency in a *forced high tension* carbon is obtained only at the expense of life; that a *molded* carbon is, generally speaking, superior to a *forced* for high tension and vice versa for low tension.

In the case of the high tension carbon B and D, the diameters are smaller than those of the other pencils, hence we are to expect a relatively higher efficiency, since as was shown last year the efficiency varies inversely as the diameter."[8]

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[6] E. G. Merritt: Some Determinations of the Energy of the Light from Incandescent Lamps. *Amer. Jour. Science.* Vol. 37. p. 167.

[7] H. Nakano: Efficiency of the Arc Lamp; Transactions Amer. Inst. Elec. Eng. Vol. VI, p. 308.

A point of interest brought out by these tests (Tables 10 and 11 and Figs. 18 and 19), is the fact that while the life of a copper-plated carbon is greater than that of an unplated carbon of the same diameter and type, the mean spherical efficiency appears to be the same for both.

Two sets of pencils of the brand (B), the one unplated and the other plated, were burned to ascertain this relation. The results show that the horizontal and the maximum efficiency of the copper-plated carbons were a little greater than those of the uncoated pencils respectively, and the mean spherical efficiency in the latter case was very slightly less than in the former. As can be seen from Table 16, the life of the "positive" plated pencil (12" long) was 10.64 hours, while that of the naked carbon was 9.16 hours, the current and P. D. having been the same for both cases.

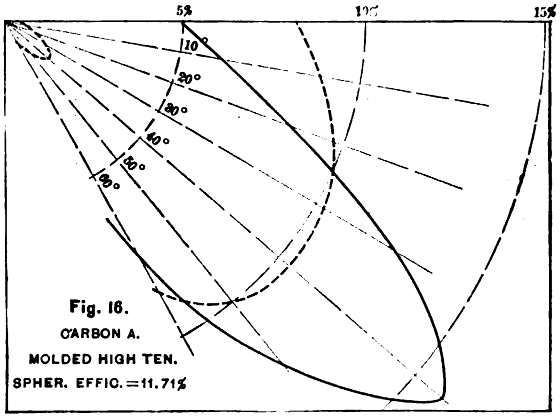

Fig. 16.
CARBON A.
MOLDED HIGH TEN.
SPHER. EFFIC. = 11.71%

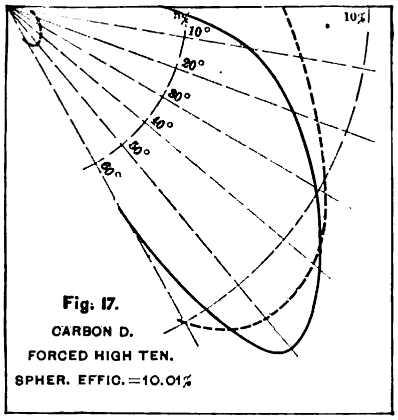

Fig. 17.
CARBON D.
FORCED HIGH TEN.
SPHER. EFFIC. = 10.01%

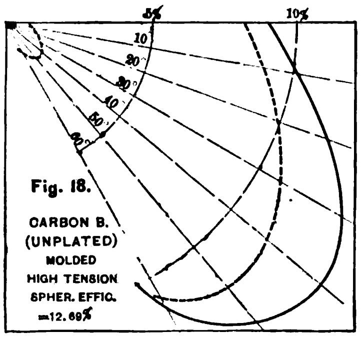

Fig. 18.
CARBON B.
(UNPLATED)
MOLDED
HIGH TENSION
SPHER. EFFIC.
= 12.69%

No positive explanation of this phenomenon has yet been given, but it appears that the actual amount of *combustion* in both cases is the same, while the *disintegration* caused by the passage of the current is greater in the case of the unplated carbon.

CANDLE POWER MEASUREMENTS.

The candle-power measurements consisted chiefly in the determination of the hemispherical candle-power of the different pencils, and from this quantity the watts per spherical candle-power produced.

The runs were made under the same conditions as in the efficiency tests. For high tension carbons current = 9 amperes and P. D. = 45 volts. For low tension pencils, current = 21.5 amperes and P. D. = 30 volts.

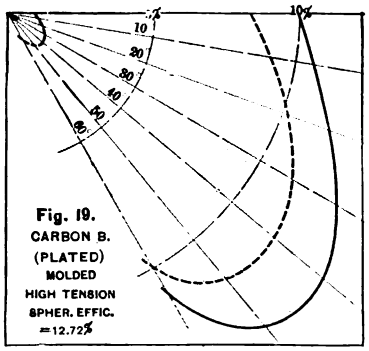

Fig. 19.
CARBON B.
(PLATED)
MOLDED
HIGH TENSION
SPHER. EFFIC.
= 12.72%

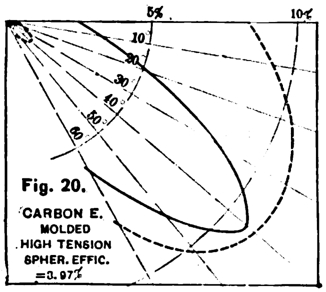

Fig. 20.
CARBON E.
MOLDED
HIGH TENSION
SPHER. EFFIC.
= 3.97%

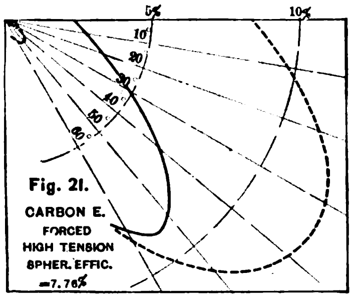

Fig. 21.
CARBON E.
FORCED
HIGH TENSION
SPHER. EFFIC.
= 7.76%

To ascertain the candle-powers, the method of the Franklin Institute Committee was used.[9] The photometric apparatus was somewhat different in detail from that ordinarily used in measuring the candle-power of incandescent lamps and deserves a brief description.

The arc-lamp was suspended from an arm which could be rotated about an axis parallel to the photometer bar and vertically above it. By manipulating a rope connected with the arm, the latter could be raised until it was at right angles with the photometer-bar, or lowered until it was horizontal. The arm being horizontal, the lamp was hung from its extremity so that the arc was on a level with the center of the photometer-disc. It will be seen that when the arm was pulled up, the arc described a vertical circle, the axis of which was a line parallel to the photometer-bar and passing through the center of the disc. The centre of the vertical circle was at the point (800) of a scale graduated into (1,000) divisions, and the radius equal to the length of 200 scale divisions.

At the zero of the scale was placed a Weston incandescent lamp, and a circular mirror of silvered glass, the axis of which was horizontal and inclined 45° to the reflecting surface; it was mounted on the bar so that its centre coincided exactly with the 800th division of the scale. Thus the distance between the arc-lamp and the mirror was rendered constant for all elevations of the former, and when the mirror reflected the light of the lamp upon the disc, the angles of incidence and reflection were always equal to 45°. The virtual image of the arc under these circumstances was at the 1,000th division of the scale. The Weston lamp was used as a secondary standard and maintained by a storage battery throughout the runs at 115 volts; its candle-power was ascertained before and after the tests by comparing it with a standard Methven "Board of Trade" 2 c. p. slit.

Photometer readings were made as in the case of the efficiency tests, at 0° and at 10°, 20°, 30°, 40°, 50°, and 60°, below the horizontal, the mean of twenty observations being taken for each elevation. These measurements were multiplied by the candle-power of the secondary standard and corrected for absorption of light by the mirror.

Tables 17-23 give the corrected data, which form the basis of the candle-power curves (Figs. 24 and 25). Distance measured along the radii from the origin to each curve, give the candle-power for the various angles. The mean spherical candle power for any case is measured by the radius of a semi-circle whose arc is equal to the area of the c. p. curve.

Although great care was taken in ascertaining the candle-powers, the difference in color between the light emitted by the arc and that given by the standard was so marked that the setting of the photometer-carriage was to a large extent a matter of personal judgment; hence the measurements given cannot be considered as absolute, but rather as relative values.

The conclusions drawn from the efficiency curves hold generally, as will be seen by an examination of Table 24, for the candle-power curves. From the latter it appears that the efficiency of low tension carbons, and especially of *molded* low tension pencils, is comparatively small. While the efficiencies of molded high tension carbons are as high as .953 and .888 watt per spherical candle, or 783 and 840 candles per electrical horse-power expended in the lamp, the efficiencies of low tension pencils of nearly the same diameter as the high are as small as 1.255 and 1.612 watts per candle, or 594 and 502 candles per electrical horse-power.

This fact is not brought out in Table 16, for reference to the latter shows the low tension pencils to have a rather high efficiency, and in some cases considerably higher than the high tension carbons. However, when the energy expended in the lamp in the two cases respectively is taken into account, the explanation of the high values for carbons A and B (Table 16, low tension) is apparent.

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[8] H. Nakano.

[9] Reports: International Electrical Exhibition of Franklin Inst., 1884. Group B. Sections V and VIII.

CANDLE-POWER MEASUREMENTS.

Table 17. *Carbon A; molded high tension.*

Angle.	Candle-Power.
0°	221.3
10°	474.1
20°	713.1
30°	979.2
40°	1053.0
50°	928.6
60°	370.7

Table 18. *Carbon B; molded high tension.*

Angle.	Candle-power.
0°	382.2
10°	638.4
20°	908.4
30°	1113.
40°	1131.
50°	749.3
60°	579.8

Table 19. *Carbon D; forced high tension.*

Angle.	Candle-power.
0°	210.5
10°	407.4
20°	687.4
30°	977.1
40°	1079.0
50°	1140.
60°	595.7

Table 20. *Carbon E; molded high tension.*

Angle.	Candle-power.
0°	227.3
10°	288.8
20°	429.9
30°	722.2
40°	957.2
50°	1080.0
60°	414.0

Table 21. *Carbon E; forced high tension.*

Angle.	Candle-power.
0°	221.7
10°	238.
20°	350.1
30°	558.9
40°	626.3
50°	630.7
60°	265.5

Table 22. *Carbon A; forced low tension.*

Angle.	Candle-power.
0°	593.7
10°	712.1
20°	866.3
30°	1094.
40°	1183.
50°	682.2
60°	495.4

Table 23. *Carbon B; molded low tension.*

Angle.	Candle-power.
0°	475.4
10°	593.7
20°	720.9
30°	871.3
40°	866.6
50°	528.4
60°	354.8

Carbon B (molded high ten., Table 24), it will be noted has the highest efficiency of the group. This is due largely to the fact that its diameter is smaller than that of any of the others, for "the candle-power varies inversely as the diameter."[10]

Similarly the relatively high candle-power of carbon D is accounted for by the small diameter of the pencil. In Table 24 and the candle-power curves, we again note the comparatively small efficiency of *forced* high tension carbons.

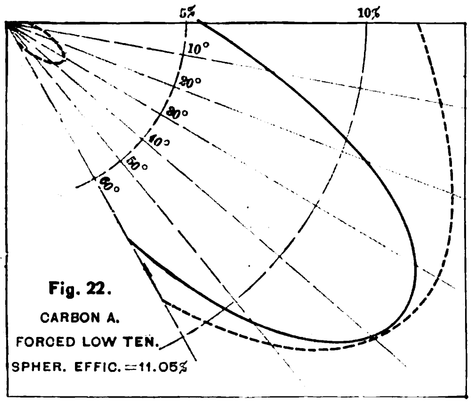

Fig. 22.
CARBON A.
FORCED LOW TEN.
SPHER. EFFIC.=11.05%

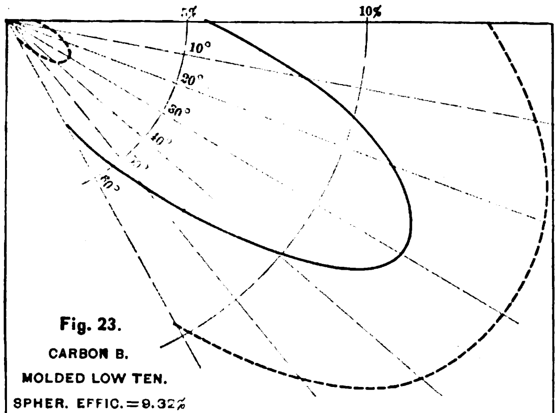

Fig. 23.
CARBON B.
MOLDED LOW TEN.
SPHER. EFFIC.=9.32%

The efficiency of carbon A (molded high tension, Table 16), as measured by $\left\{\frac{\text{luminous radiation}}{\text{total radiation}}\right\}$ is larger than that of carbon D; yet the mean spherical candle-power of the latter is greater than that of the former (Table 24). The explanation of this phenomenon (assuming the measurements to be correct) probably lies in the difference in the *quality* of the light emitted.[11]

In some instances it is desirable to ascertain the mean spherical candle-power of a lamp approximately, without taking the time to integrate the curve.

The formula given by M. Gérard, namely, "spherical c. p. = ½ horizontal c. p. + ¼ maximum c. p."[12] is of sufficient exactitude for practical purposes. Gérard gives the following table showing the observed and calculated spherical candle-powers for seven lamps.

Table 24.

CANDLE-POWER MEASUREMENTS.

Carbons.	Diam. (mean) inches.	Resis. ohms.	C. amp.	P. D. volts.	Horizontal Candle-power.	Maximum c. p.	Hemispherical c. p.	Watts per spher. c. p.	Spher. c. p. per Elec. horse-power.
A molded high ten........	.508	.203	9	45	221	1053	456	.888	840
D forced high ten	.457	.187	9	45	210	1140	486	.833	895
B unplated molded high ten.	.453	.224	9	45	382	1131	525	.771	967
E molded high ten	.533	.202	9	45	227	1080	425	.953	783
E forced high ten.........	.522	.251	9	45	222	626	288	1.407	531
A forced low ten..........	.500	.072	21.5	20	594	1183	514	1.255	594
B molded low ten..........	.498	.071	21.5	30	475	871	400	1.612	503

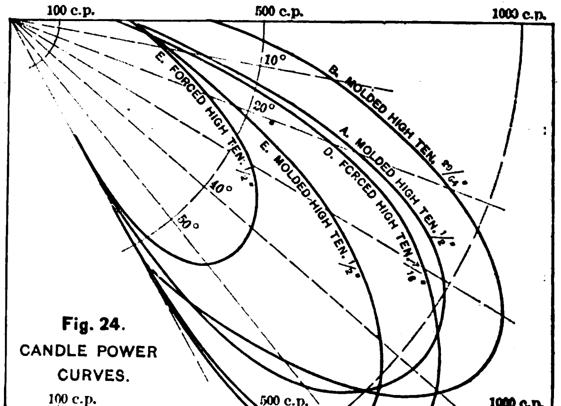

Fig. 24.
CANDLE POWER
CURVES.

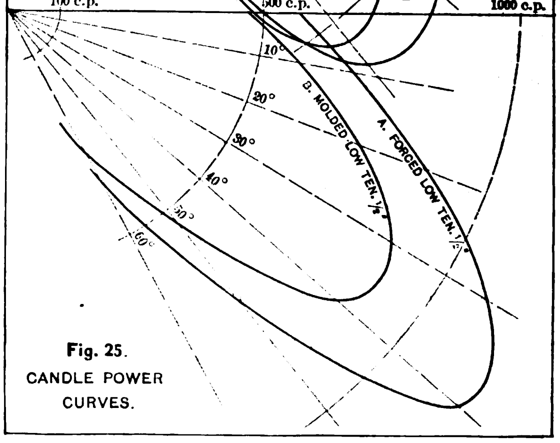

Fig. 25.
CANDLE POWER
CURVES.

Table 25.

Gérard's Measurements of Candle-Power.

Lamps.	Horizontal c. p.	Maximum c. p.	Spherical c. p. calculated.	Spherical c. p. observed.
No. 1	250	1464	491	470
" 2	456	3250	1040	1145
" 3	560	3071	1048	1221
" 4	744	1227	679	692
" 5	122	840	271	274
" 6	586	2100	818	802
" 7	935	1150	755	707

Taking the whole number of lamps, the average error is only five per cent. "The angle of maximum intensity was about 45° usually, but in some cases it approached that of 30°, or 60° from the horizontal."

Data collected from various sources, including the tests of the Franklin Institute Committee in 1884, are given in Table 26. From the horizontal and maximum candle-powers, the mean spherical was calculated by Gérard's law. Comparison with the observed candle-powers shows that in some cases the error is less than one per cent. The mean error is, however, larger than that obtained by Gérard, and reaches about 9¾ per cent. Hence, as was stated before, the law is valueless except in cases of rough approximation.

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[10] M. Schreihage: Centralblatt für Elektrotechnik, No. 22, 1888.

[11] The reader is referred in this connection to "A Spectrophotometric Comparison of Artificial Sources of Illumination." Paper by Edward L. Nichols and W. S. Franklin, read before A. A. A. S. at Cleveland, August, 1888.

[12] M. Gérard: Candle-Power of Arc Lamps:—Centralblatt für Electrotechnik; also N. Y. Elec. World, Jan. 25th, 1890.

TABLE 26.

Candle-Power Calculations, using Gérard's Law.

LAMPS.	Horizon. c. p.	Max. c. p.	Spherical c. p. observed.	Spherical c. p. calculated.	Authority.
Weston	344	609	348	324	B. W. Snow.
"	299	576	295	293	"
"	576	1235	640	597	"
Brush..................	313	1395	609	504	"
Ball..................	233	534	240	249	Prof. W. A. Anthony
Brush (1,200 c. p.)..........	180	617	263	244	"
Brush (2,000 c. p.)..........	389	1380	653	530	"
Van Depoele (20 light).....	451	1377	574	569	"
Van Depoele (60 light). ..	333	1155	470	455	"
Western Elec	263	855	186	220	"
Thomson-Houston	227	1080	425	383	L. B. Marks.
" "	222	626	288	267	"
" "	382	1131	525	474	"
Weston..................	594	1183	514	593	"
"	475	871	400	436	"

Reference has been made to the fact that while the curve for luminous radiation is similar to that of candle-power, the curve for total radiation differs widely from the latter. As the efficiency depends upon the ratio $\left\{\frac{\text{luminous radiation}}{\text{total radiation}}\right\}$ it is plain that Gérard's law will not hold for calculating the mean spherical efficiency from the horizontal and the maximum. But again, for approximations a similar law holds, *i. e.*,

Spherical efficiency = ¼ *horizontal* + ¾ *maximum.*

Although the topic of efficiencies has been discussed in another part of the article, it may not be out of place to add a few words here, bearing upon the law in question. Measurements of horizontal, maximum and mean spherical efficiency, made by Mr. H. Nakano and by the writer, are given in Table 27, and the last law mentioned applied in the calculation of the spherical efficiency. In some cases the error is exceedingly small while in others it is comparatively large; the mean error of 14 tests is not quite eight per cent.

TABLE 27.

Observed and Calculated Efficiencies.

CARBON.	Horizon. Effic.	Max. Effic.	Spherical Effic. observed.	Spherical Effic. calculated.
.882 inch.	1.82%	9.00%	6.87%	5.60%
.563 "	4.12%	14.41%	11.00%	11.83%
.500 "	4.91%	17.33%	12.66%	14.22%
.450 "	5.48%	15.52%	13.30%	13.01%
.370 "	5.55%	17.50%	15 54%	14 51%
.250 "	8.44%	19.80%	16.60%	16.96%
A molded high ten.	5.53%	16.21%	11.71%	13.53%
D forced "	4.42%	12 57%	10.01%	10.53%
B (unplated) "	8.89%	13.52%	12.69%	12.37%
B (plated) "	9.91%	13.69%	12.72%	12.75%
E molded "	2.33%	11.05%	8.96%	8.87%
E forced "	2.28%	8.95%	7.76%	7.29%
A forced low ten.	5.42%	13.51%	11.05%	12.68%
B molded "	5.69%	12.73%	9.32%	10.96%

OBSERVATIONS OF THE ARC AND THE CARBON-POINTS.

With a given potential difference between the terminals of the lamp, the length of the arc depends upon the current flowing, and increased as the current becomes greater. If the current be kept constant, the length of the arc increases with the P. D.

Data given in Tables 28 and 29 show the length of the arc for both cases.

In order to measure the length of the arc, a lens was so mounted as to throw the magnified image of the former upon a surface carrying a vertical scale. Then after measuring the distance between the magnified points and applying the proper reduction factor, an additive correction was made for the depth of the crater, thus giving the length of arc from the tip of the minus pencil to the point directly above in the centre of the crater of the plus.

From the figures (Tables 28 and 29), it seems that no direct relation exists between the length of the arc and the current and P. D. In the case of the carbons tested, the length of the arc with constant potential increased very rapidly as the current was changed from 6 to 9 amperes, and then gained slowly from 9 to 13 amperes. The nature of the change was somewhat different in the constant current runs, the length of the arc increasing more nearly as the square of the voltage.

After each of the runs noted in Tables 28 and 29, the carbon-points were examined, and it was found that the latter assumed particular shapes depending upon the current and P. D. used. Another series of tests were made with carbons C. and E. (molded high ten), in which the current ranged from 5 to 15 amperes, the P. D. being kept constant at 50 volts.

TABLE 28.

Length of Arc: Constant Potential.

CARBON.	Current amp.	P. D. volts.	Length of arc; inches.
E, molded high tension.	6	50	.087
" "	7	"	.114
" "	8	"	.137
" "	9	"	.147
" "	10	"	.150
" "	11	"	.154
" "	12	"	.156
" "	13	"	.167

TABLE 29.

Length of Arc: Constant Current.

CARBON.	Current amp.	P. D. volts.	Length of arc; inches.
E, molded high tension.	10	40	.073
" "	"	45	.096
" "	"	50	.141
" "	"	55	.186
" "	"	60	.216

Fig. 26 shows the form of the points with different currents. Nos. 1, 2 and 3 are pencils of the brand C. and 4, 5, 6 and 7 of the type E. The photographs of the carbons are three-quarters of the actual size.

Examining the first three pencils, we see that with 5 amperes, there is a tendency to form a "mushroom" on the lower or negative carbon; the latter is eaten away considerably just below the tip. With 10 amperes this tendency is not at all marked and at 15, almost inappreciable.

Glancing at the upper or plus carbons, it appears that the smaller the current, the more nearly does the positive pencil burn to a point; that is, the smaller the diameter of the crater. But though the width of the crater is less in the case of low currents than with high, the depth of the former is correspondingly greater. The photographs do not bring out this point, but an inspection of the tip of the lower carbon gives a clue to the facts. Note that with small currents the negative electrode terminates in a pointed, sometimes globular projection. As has been stated before, this tip becomes less noticeable with increase of current, a fact which is brought out by inspecting Nos. 7, 6, 5 and 4 (Fig. 26). In No. 4, burned at 15 amperes, the end of the lower carbon is blunted; the depth of the crater in the upper was practically zero. In Nos. 5, 6 and 7, burned at 12, 9 and 6 amperes respectively, the depth of the crater increases as the current diminishes.

With high currents, the carbon is disintegrated to a greater distance above the point than with low.

Fig. 27 shows the form of the carbon points when the latter are burned with constant current=10 amperes. The range in P. D. was from 40 to 60 volts.

Just as the peculiar burning of the tip distinguishes a pencil fed by a low from one burned at a high current, so the form of the carbon-point differs in the case of a pencil burned with low voltage than with high. In Nos. 1, 2, 3, 4 and 5, Fig. 27, the gradual change in the formation, from a sharp projection at 40 volts to a blunt end at 60 volts is noticeable.

The "mushroom" which invariably forms in carbons burned at a low current and high voltage, is absent when the pencils are burned at high current and low voltage.[13] In the former instance the thin neck of the "mushroom" often breaks, thus arresting the current and extinguishing the arc. In the latter case the end of the carbon is prone to so burn away as to leave a concave outline. (See No. 1, Fig. 27.)

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[13] When the carbon is impure and contains a large amount of silica, the latter is often deposited in the form of a glass bead on the point of the negative pencil. The "mushroom" alluded to in the text does not refer to this deposition.

[14] O. G. Pritchard: Electric Arc Light Carbons. London Elec., Mar. 21st and Apr. 4th, 1890.

At 40 volts the depth of the crater measured .051 inch. At 60 volts the crater disappeared ; the carbons also "flamed" at this high voltage.

With a given current there is for every brand of carbon a certain voltage, above which, if the pencil be burned, "flaming" will result. A simple trial is sufficient to determine this critical point.[14] Again, there is a voltage below which, if the carbon be burned, "hissing" takes place. With perfectly centered carbons there is no difficulty in ascertaining the latter point.

Careful observation of the arc shows that when the tension is too high for a given carbon, the walls of the crater break away, allowing the arc to play on the outside surface of the carbon. This action is always accompanied by a flame, which shoots from the negative carbon. On placing the negative pencil above and the positive below, the flame shoots down. With soft-cored carbons, well centered, one cause of flaming,—namely, liability of the arc to play laterally,—is obviated; and if the pencils be burned with the proper current and voltage, there seems to be no reason why this disagreeable feature of the arc lamp should not be entirely overcome.

There is not so much liability to "hiss" in a high tension system as in a low, for from the formation of the carbon-points when the pencils are burned in commercial low tension lamps, it appears that the minus carbon terminates in a small mushroom-button. The breaking of this pellicle of carbon and the consequent action of the lamp-mechanism to reduce the rise in potential due to the rupture, invariably result in the "hissing" of the arc.

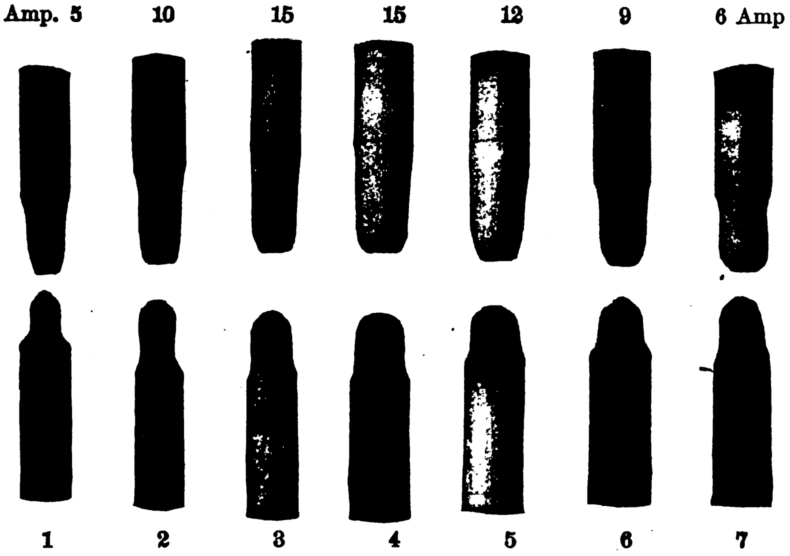

FIG. 26.

Form of the Carbon Points: Constant Potential—50 volts.

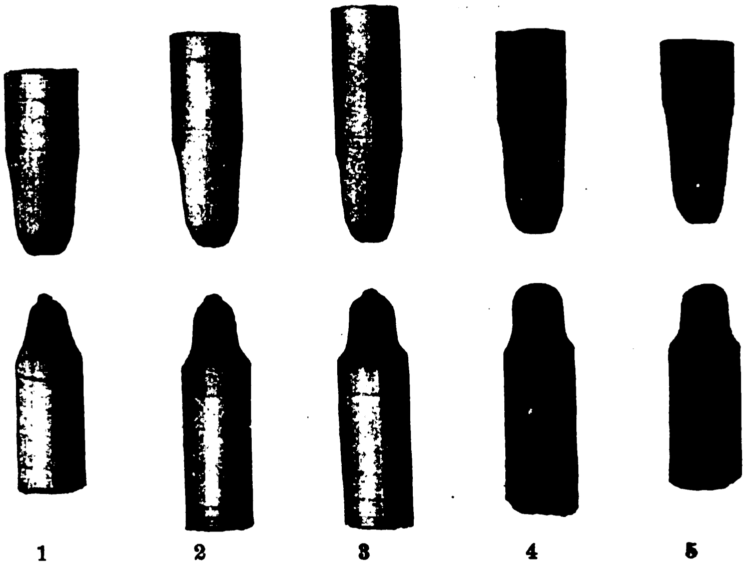

FIG. 27.

Form of the Carbon Points: Constant Current—10 Amperes.

Most of the irregularities in the action of arc-lamps probably result more from the unsuitableness of the carbon than from defects in the lamp-mechanism or changes in the strength of the current and P. D. in the line.

The remedy lies with the carbon-manufacturer. A careful study of the relation between the miscroscopical structure of the pencil and the action of the latter in a given case would be likely to bear fruitful results. Of course the field for experimentation is large, but the improvements which must necessarily follow conscientious research will undoubtedly be of great scientific as well as commercial value.

In the present state of the art of carbon-manufacture, it is the central-station manager who must exercise great discrimination in the selection of arc-light pencils for his plant. Mr. E. F. Peck has recently shown how a "comparative test of the best known carbons in the market" resulted in "a saving of 64.73 electrical horse-power in a station burning a thousand arc-lamps."[15]

But there is no reason why the carbon-manufacturer, given the condition of a lighting system as regards current, tension, required light and life of pencils, etc.—should not be able to produce a carbon specially adapted to the needs of that system.

When the root of existing defects is thus struck at, the solution of the arc-light carbon problem will be at hand.

The experiments published in this paper were made under the direction of Professor Edward L. Nichols, in the laboratory of Cornell University. The writer is indebted to Mr. A. B. Levy, P. G., for valuable assistance in the work.

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15. E. F. Peck of Brooklyn, N. Y.; Carbon Tests,—paper read before National Elec. Light Assoc'n; Kansas City Convention, Feb. 1890.

NOTE ON A NEW PHOTOMETER.[1]

BY PROF. EDWARD L. NICHOLS.

Methods of photometry which take no cognizance of differences of quality are so ill adapted to the study of sources of light which differ from each other widely in temperature, that the introduction of some instrument by means of which both the character and intensity of an illuminant can be readily determined, would be a desirable adjunct to the equipment of our photometer rooms.

The instrument which it is my purpose to describe has been designed to meet this need. Existing types of the spectro-photometer may be made to give good results, but they are expensive instruments and so difficult to use that it is only in the hands of observers of considerable experience that accuracy is assured.

The new apparatus, the "horizontal-slit" photometer, is in point of fact a spectro-photometer in which the polarizing device is entirely done away with. In it the extremely simple principle of the Bunsen photometer is applied successively to the various regions of the visible spectra of the source of light which are to be compared. A direct vision spectroscope of Browning's form is attached to the usual car of a Bunsen photometer, from which the disk and mirrors have been removed. The optical axis of the collimator is horizontal and at right angles to the photometer bar. The slit is horizontal and lies in a straight line, joining the sources of light, which are set up in the usual manner at the ends of the bar. The bar itself is preferably of considerable length; in the case of the one upon which the original instrument under consideration was mounted, it was 500 c. m. long, and should be divided into 1,000 equal parts.

In front of the spectroscope slit are placed two right angled prisms of the same size and made of the same glass (see Fig. 1). Their vertical adjacent edges bisect the slit, and light traveling from either end of the photometer bar is totally reflected by them and enters the right or left hand end of the slit in a direction parallel to the optical axis of the collimator tube.

The two sets of rays thus gathered into the spectroscope from the lights at the end of the bar are vertically dispersed by the Amici prisms and appear in the field of view as two vertical spectra standing side by side. Equal wave lengths are in the same horizontal line and any desired region may be brought into the centre of the field by an angular movement of the ocular telescope. The telescope moves along the arc of a suitably divided semi-circle, to which it may be clamped by means of a set-screw. Wave lengths corresponding to the various circle settings are determined once for all, by observation of the more prominent of the Fraunhofer lines.

When the instrument, thus mounted, is placed at the middle of the photometer bar, between lamps which are identical in intensity and quality, the two spectra are of equal brightness throughout, wave length for wave length, from red to violet. If the two lamps differ in intensity but not in quality, the two spectra will differ in brightness by the same amount from end to end, and a position may be found upon the bar for which they will be identical throughout.

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1. A paper read before the American Institute of Electrical Engineers, Boston, May 21st, 1890.

Under these circumstances, which are the only ones in which the Bunsen method in photometry is strictly applicable, the instrument may be used as a simple photometer, the setting for any wave length whatever giving the candle-power. For this purpose alone, viz., for the comparison of lights of similar character, the instrument offers certain manifest advantages over the various forms of the Bunsen photometer. In the course of the present paper I shall present some definite data concerning the relative sensitiveness of the two instruments when used in this way.

When the lights to be compared differ both in intensity and quality, ordinary photometric indications possess no perfectly definite significance. In this, which is the more general case, the relative brightness of the spectra of the two sources varies with the wave length. For each region of the visible spectrum, however, a position upon the photometer bar can be found at which the brightness of the two spectra in that region will be equal, and the observations thus obtained, when extended over the entire spectrum, will afford data by means of which the differences in quality of the two sources of light may be definitely expressed.

In a recent paper read before the Institute,[2] for a considerable range of temperature at least, the ratio between the intensities of a certain wave length of the spectrum of glowing carbon, is identical with the ratio of candle-powers as determined by the Bunsen photometer. The wave length in question, determined from the intensity of the spectrum of incandescent lamps at various candle-powers, I had found to be approximately $\lambda=600$. M. A. Crova, in an important paper since presented at the late electrical congress at Paris[3] has pointed out the importance of this method of measuring the light from sources differing in temperature. The wave length which he has indicated for this purpose is $\lambda=582$, which belongs to a region lying slightly further toward the green than the one which I had adopted.

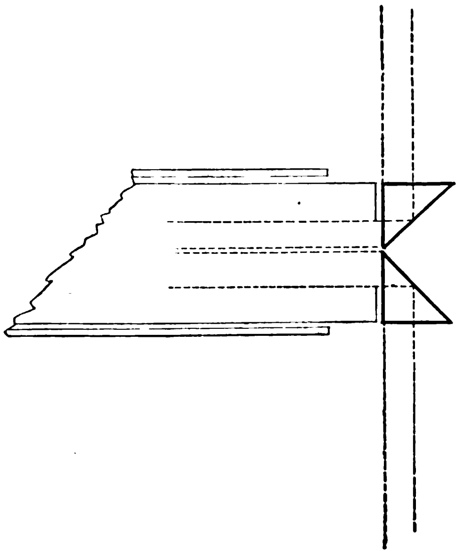

FIG. 1.—A NEW PHOTOMETER.

When the wave length of this region has been established beyond question, the photometry of lights which vary in color. will have been reduced to a definite scientific basis. Instead of attempting to use the Bunsen photometer in measurements to which it is not adapted, we shall be able to deduce the relative candle power of two sources of light from the comparison of a single wave length, and we shall be freed from the uncertainty arising from differences of color and from the personal errors due to the independent use of the two eyes in observation. The determination of candle-power will then be an operation of precision, even when the sources of light to be compared vary widely in temperature. It is in the opportunity of performing such observations upon the photometer bar itself, under conditions which do away with many of the sources of error inherent in the usual methods of spectro-photometry, that the chief advantages of the new photometer will be found to lie.

The following set of observations, taken with the new instrument, may serve to indicate one of the uses to which it may be put. The data[4] are taken from an investigation now in progress in the Physical Laboratory of Cornell University. The object in view was to compare the spectrum of a novel type of gas burner with that of an ordinary argand burner. The two lamps were set up at the ends of a photometer bar five meters long, the bar, as already stated being divided into 1,000 equal parts. Readings were taken at six points in the spectrum. The purposes being to express the relative brightness of the two spectra, wave length for wave length, the intensity of that due to the argand burner was taken as unity throughout, and the brightness of each region of the spectrum of the flame under investigation was obtained in terms of that of the corresponding region of the spectrum of the argand. The results are given in Table 1:

TABLE 1.

Comparison of the spectrum of a Welsbach burner with that of an ordinary argand burner, by means of the "horizontal-slit" photometer.[4]

Color.	Wave length	Light-ratio $\frac{\text{Welsbach}}{\text{Argand.}}$	Probable error of a single observation.
Red	702	0.709 ± .017	2.45%
Yellow	589	1.476 ± .017	1.14%
Green	558	1.760 ± .023	1.34%
	500	2.895 ± .047	1.99%
Blue	466	2.738 ± .036	1.30%
Violet	439	3.090 ± .073	2.35%
			1.76% (average

Ten observations were made in each region.

I introduce these measurements here simply as an illustration of one line of work to which the instrument under consideration is adapted. A full description of the research of which they form a part, and which covers many other questions pertaining to the very interesting class of lamps with which it deals, will doubtless be published in due time.

As will be seen from the column of probable errors, the sensitiveness of the instrument is greatest in the region of the D line (λ—589) and least in the extreme red and violet, where the light intensities are small.

A set of ten determinations made by the same observer with the Bunsen photometer, gave for the total light-ratio of the two lamps:

$$\frac{\text{Welsbach}}{\text{Argand}} — 1.701 \pm .015$$

The probable error of a single observation in this series amounted to 0.89%, a value somewhat smaller than that obtained with the new photometer in the yellow of the spectrum.

The number of observations is too small to afford a close estimate of the relative sensitiveness of the two instruments, but the results suffice to show that the "horizontal-slit" photometer does not differ appreciably in accuracy from the Bunsen photometer when the latter is used in the comparison of flames of the same color.

When it comes to the measurement of sources of light that differ widely in temperature, the comparison is decidedly in favor of the "horizontal-slit" photometer, the sensitiveness of which is not affected by differences of color. The error of the Bunsen photometer in candle-power measurement of the arc light, for instance, calculated from ten observations recently made upon the same photometer bar, the reference standard being an argand gas burner, was 2.65% (probable error of a single observation), a value more than twice as large as that of the "horizontal-slit" photometer.

A comparison of the performance of the new photometer with that of a polarizing spectro-photometer of the type which is commonly recognized as affording the highest degree of accuracy, is likewise decidedly in favor of the former. Taking as a basis eight observations made by Mr. Franklin and myself in the study of a bat's-wing gas burner,[5] the observations covering eight regions of the spectrum, I find the error of a single observation, in the various regions, to have been as follows:

TABLE 2.

Probable errors of a single observation with a polarizing spectro-photometer, calculated from sets of ten observations upon various portions of the spectrum of a gas flame.

Wave lengths.	Probable error of a single observation.
758	7.9%
668	4.9%
608	4.5%
557	5.4%
518	6.4%
492	7.0%
468	3.0%
450	2.4%
	5.2% (average.)

The measurement of a fluctuating illuminant, such as the gas-flame, is a line of investigation by no means adapted to exhibit any photometric instrument at its best; but as the errors of the horizontal-slit photometer, already given, were calculated from sets of ten observations upon such flames, I have selected for comparison similar sets of ten upon sources of the same character.

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[2] Transactions of the American Institute of Electrical Engineers, vol. 6, p. 183.

[3] M. A. Crova, *La Lumière Electrique*, vol. 33, p. 478.

[4] From observations by Miss Ida M. Hill.

[5] American Journal of Science, vol. 38, p. 100. See also Transactions of American Institute of Electrical Engineers, vol. 6, p. 177.

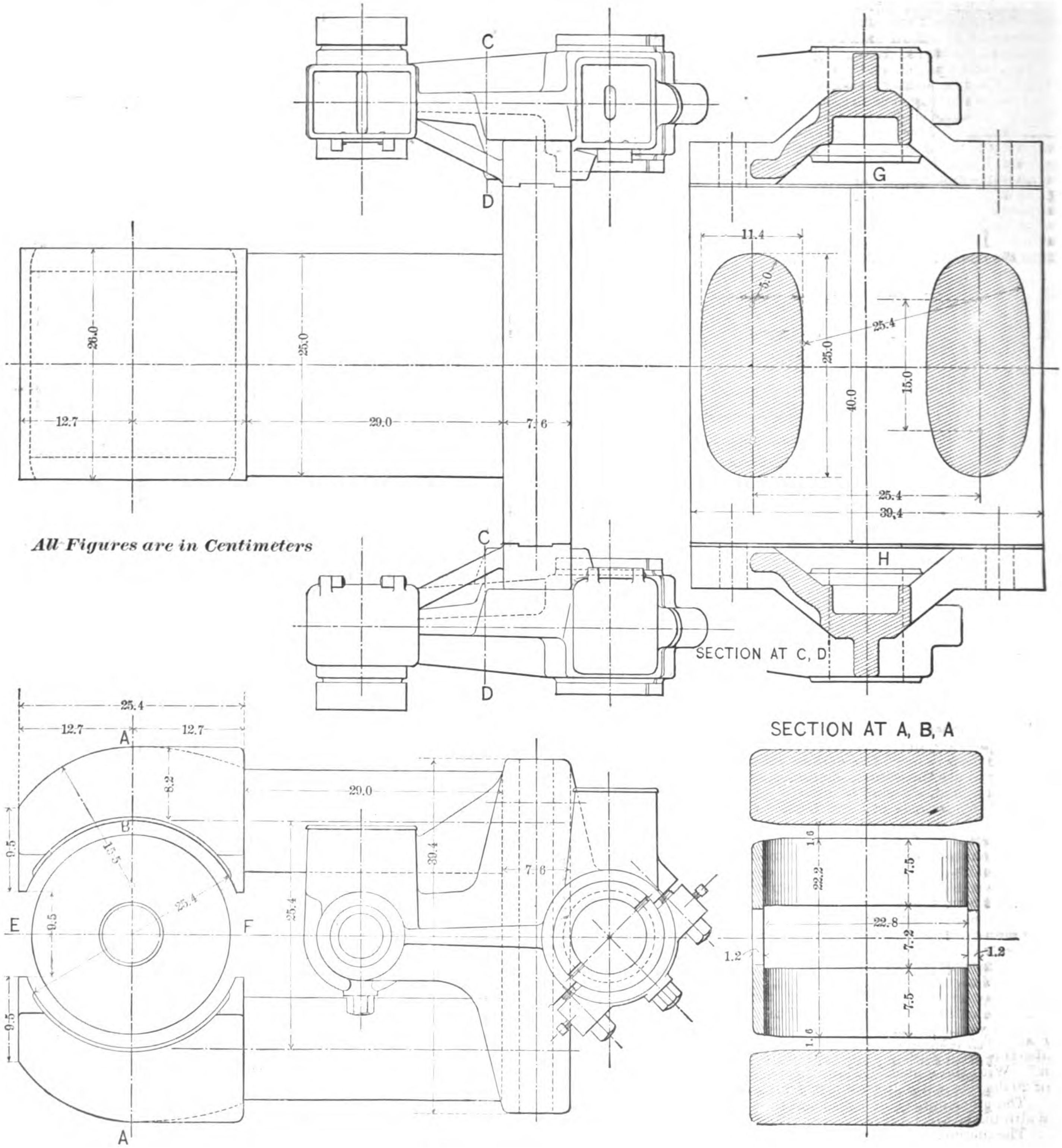
The averages, viz.:

Error of horizontal-slit photometer, 1.76% (average for spectrum)

Error of polarizing spectro-photometer, 5.20% (average for spectrum),

doubtless afford a fair indication of the relative performance of the two instruments in this peculiarly trying line of work.

At the last annual meeting of the Institute I had the privilege of presenting a brief study of certain personal errors pertaining to the use of the Bunsen photometer. The particular class of errors to which attention was called in that paper[6] are undoubtedly obviated by the use of the horizontal-slit photometer; what new ones the latter instrument may introduce remains to be determined.



All Figures are in Centimeters

Fig. 1.—Sprague Street Car Motor.

MAGNETIC DATA OF THE SPRAGUE STREET CAR MOTOR.[1]

BY H. F. PARSHALL.

Figures giving the ratios of the lines of force through various parts of the magnetic circuit to the lines of force through the armature have occasionally been fully published, the most noticeable being those given in a paper by Hopkinson some years ago. These ratios vary in the same type of dynamo or motor with any change of proportion; or, to put it in another way, in order that these ratios may remain constant in the same type, the ratios of the magnetizing force in the one part of the magnetic circuit to the magnetizing force in the other parts must also remain constant.

In making calculations on various motors made by the Sprague

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[6] Transactions of the American Institute of Electrical Engineers, vol. 6, p. 335.

[1] A paper read before the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

Company, I have found it necessary to confirm the assumed values of these ratios by measurements. It is the object of this paper to give the results of the measurements made on the street car motor, together with sufficient description, to make the values found of some use to those engaged in similar work. If I had had any intention of publishing these results, I would have endeavored to make them, in some ways, more complete than they now are, but so little detailed information exists on this subject, I have decided to give the result of my work up to date on this particular motor. The conditions under which this work has been carried on have not at all times been the most favorable for accuracy, but in the main, the results have been satisfactory.

Figs. 1 and 1a, show the various peculiarities of the magnetic circuit, and give the dimensions of the several parts. The most noticeable points are:

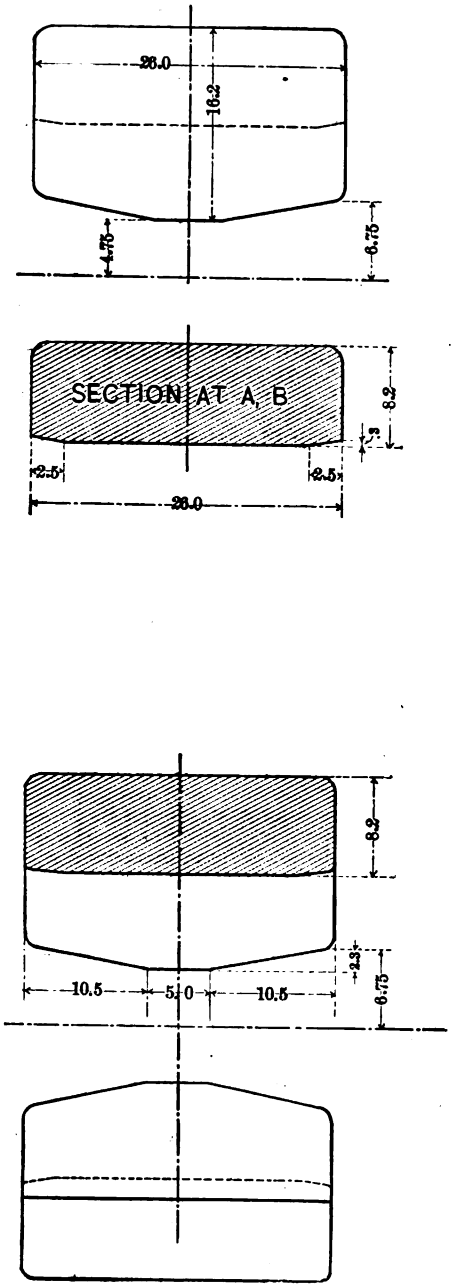

Fig. 1a.—Sprague Street Car Motor.

The bell mouthing of the pole pieces shown in the section "A B." This bell mouthing greatly lessens the sparking, as does also the cutting away of the tips of the pole pieces, as shown in "A B." With these modifications the brushes can be shifted an angle of 20 degrees without serious sparking.

The other noticeable points are the cast-iron side brackets, the width of the yoke and its comparative thinness.

The method of getting the ratio of the lines of force in one part to the lines of force in another was the usual one. Coils of a few turns were wound around these parts, and connected to a ballistic galvanometer, and when the needle was standing at zero, a known magnetising force was suddenly reversed.

The galvanometer used was an Edelmann with a heavy ring form of needle, very slightly damped. The deflections being small, it was assumed that the first throw was proportional to the induction through the measuring coil. The magnetizing coils were those commonly used on this motor.

Each coil was wound approximately to a depth of 4 centimetres, and along the cores 8.5 centimetres.

Coils were as follows:

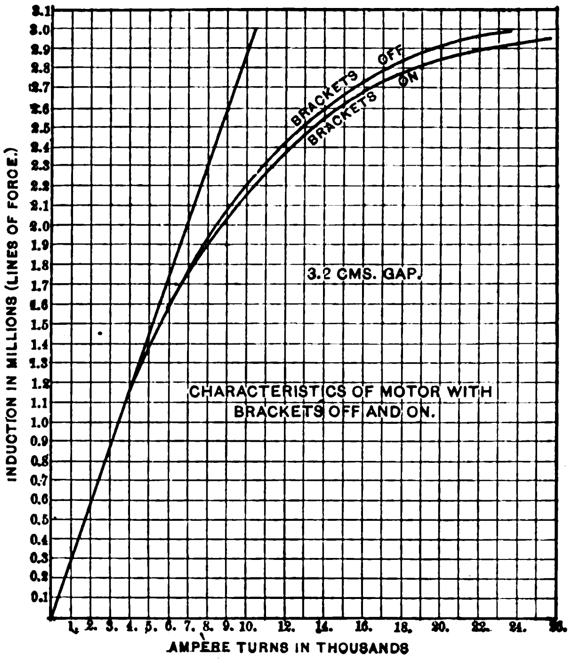

Fig. 2

First. Nearest the pole piece, 28 turns per layer, 11 layers.

Second. 31 turns per layer, 11 layers.

Third. 31 turns per layer, 13 layers.

This gives 2,104 turns for both cores, or with a current of 6.75 amperes, which was used throughout, a magnetizing force of 14,200 ampere turns.

By noticing the curves in Fig. 2 it will be seen that this is the part of the characteristic upon which the motor is most frequently worked. With different values of magnetizing force, different values of the ratios would be found. This becomes evident when we remember that the resistance of the gap remains constant, while the resistance of the iron increases with the magnetizing force. For this reason the curves of magnetization of the *different* parts of the magnetic circuit are not given.

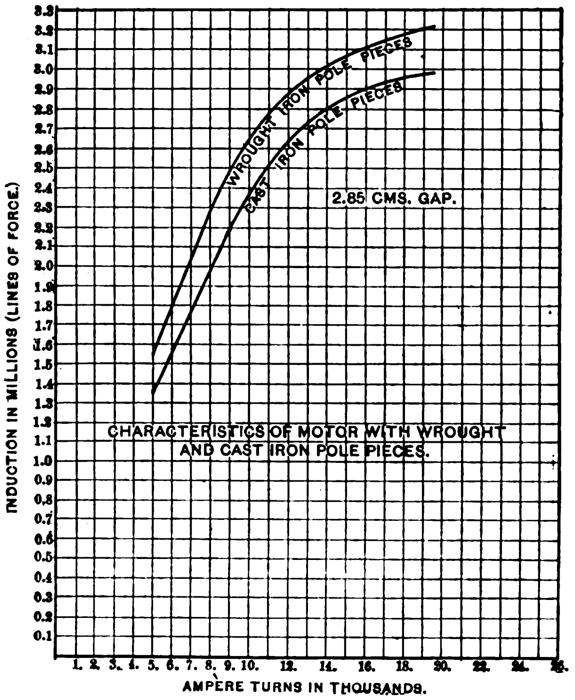

Fig. 3

The measuring coils were 4 turns of wire wound around the armature core at E. F., on the pole piece; at A. B., on the magnet core, midway between the ends; and on the yoke at G. H. Had it been possible a coil would have been wound around both the yoke and side brackets.

The following values were found:

$$\left.\frac{\text{Lines through magnet}}{\text{Lines through armature}}\right\} 1.45$$

$$\left.\frac{\text{Lines through middle of yoke}}{\text{Lines through armature}}\right\} 1.27$$

$$\left.\frac{\text{Lines through middle pole piece}}{\text{Lines through armature}}\right\} 0.666$$

Cast-iron pole pieces.

$$\left.\frac{\text{Lines through magnet}}{\text{Lines through armature}}\right\} 1.52$$

$$\left.\frac{\text{Lines through middle of yoke}}{\text{Lines through armature}}\right\} 1.33$$

$$\left.\frac{\text{Lines through middle pole pieces}}{\text{Lines through armature}}\right\} 0.7$$

The effect of the leakage from the side brackets is shown in Fig. 2, the upper curve being the characteristic with them removed, and the lower curve being the characteristic with brackets on. The dropping of the curve shows that the magnet cores are sooner saturated with the brackets on. The difference is small. It would be somewhat greater did not the brackets reinforce the yoke. These curves were first obtained by separately exciting the fields, and taking the number of revolutions, with a driving current of one ampere through the armature.

The lower curve has, by comparison, been found to be a close approximation to the characteristic when the armature is run with currents for which it was designed.

Fig. 3 shows the characteristics of two motors, one with the wrought-iron pole piece, and the other with the cast-iron pole piece, the gap being 2.85 instead of 3.2, the side brackets being on in each case. The difference between these two characteristics is somewhat striking, and carries its own lesson.

I wish here to acknowledge my indebtedness to Mr. G. J. Scott for the assistance he has given me in making measurements.

Fig. 1a shows two forms of pole piece; one has a full line. This is the cast-iron; the dotted line shows the wrought-iron pole piece.

CORRESPONDENCE.

NEW YORK AND VICINITY.

Discontinuing Subway Litigation.—Buying a Long Distance Telephone Line.—Death of Roloson, the Crack "Fast Sender."

ELIHU ROOT, on behalf of the Manhattan Electric Light Co., has filed in the Supreme Court a discontinuance of the suit of the various electric light companies against the subway company. Mr. Root said that the reason for the discontinuance was that the injunctions issued by the General Term to restrain the companies had defeated the scheme by which the Board of Electrical Control proposed to turn over the control of the subways to the Westinghouse Company, and thus removed the only cause of action which the electric companies had. As their purpose was accomplished, the discontinuance had been ordered.

At last week's meeting of the Aqueduct Board, a resolution providing for the construction of a telephone line to connect the several stations along the line of the new aqueduct was adopted. The Metropolitan Telephone and Telegraph Co. wanted the job, offering to construct the line and maintain it for five years for $5,500 a year. But engineer Fteley, claimed that with the co-operation of Public Works Commissioner Gilroy, the line—a double metallic line. with long-distance instruments at the 135th street gatehouse, Shaft 25, South Yonkers, Ardsley, Pocantico, and Croton Dam—could be built for about $5,000, and this plan was adopted.

John W. Roloson, who is believed by most telegraphers to have been the fastest sender in the world, died at his residence in Brooklyn, last week, from injuries received while riding a bicycle near Prospect Park last Sunday. Mr. Roloson attempted to wheel between two wagons, when the horse attached to one of them became frightened, bolted, and ran him down. He received severe internal injuries. Mr. Roloson was night manager of the Postal Telegraph Company, at 187 Broadway, and was one of the most popular telegraphers in the country. He was born 31 years ago in Port Jervis, N. Y. He commenced his career as a telegrapher in this city when he was 18 years old, and has worked for the Western Union, the French Cable, the Bankers and Merchants Company. the United Press, and the Associated Press. In 1884, he made the world's record for fast sending, 500 words in ten minutes and ten seconds. In 1885 he took the first prize in the tournament here, and in the opinion of not a few, he won the first prize in the recent fast-sending tournament, though he was ruled out by the judges. He was a widower, and leaves two children. He was a member of the Brooklyn Bicycle Club, and a governor of the Telegraph Club of this city.

NEW YORK, May 24, 1890.

PITTSBURGH.

Pittsburgh and Allegheny Traction Co.—The Duquesne Traction Co. —Personal Notes.—The Allegheny County Light Co.

THE stockholders of the Pittsburgh and Allegheny Traction Co. met a few days ago to increase the capital stock of the corporation to $3,000,000, for the purpose of changing the motive power on all their roads from horses to electric motors. Their lines are known as the Union line, the Rebecca street line, the Western avenue line and the Troy Hill line. Great improvements will also be necessitated on the Suspension Bridge, a structure over the Allegheny river, which has to be utilized by all other lines. The Pittsburgh and Allegheny Traction Co. is one of the most profitable street car corporations in this town, and it is expected that the change of the motive power will make it even more prosperous.

The Oakmont and Verona Traction Co. was chartered a few days ago, and another electric railroad will be the result in the vicinity of Pittsburgh.

The Duquesne Traction Co. and the Pittsburgh Traction Co. are about to fight out their difficulties in the Supreme Court, Philadelphia. These two corporations have for some time been at loggerheads as to who should have the right of laying tracks on certain streets in this city.

Mr. J. E. Powell, superintendent of electricity of the Treasury department, Washington, D. C., has arrived in the city to look after the wiring which is to be done in the new government building.

The Birmingham Traction Co., which is to convert its road into an electric street car line, has broken ground for laying new tracks and the cars are expected to be running in the fall.

Mr. L. B. Stillwell, well known as one of the capable assistants to electrician Shallenberger, of the Westinghouse Electric Co., sailed for England a few days ago. Mr. Stillwell will remain on the other side for a considerable time to devote his attention to work connected with the Westinghouse Electric Co., Limited, of London.

The Allegheny County Light Co. of this city have now 32,000 16 c. p. lamps connected and in nightly operation. They added lately two new 60 light arc machines of the Westinghouse arc light type to their plant and they also installed a 75 h. p. incandescent motor machine. The company have the floor of its central station covered with a paint containing a mixture of varnish and wax which has the peculiar property of driving off all the oil dropping on the floor, and thus keeping it constantly clean. A number of electric light men who have seen the floor became so much impressed with the advantage of this scheme that they have also adopted it.

PITTSBURGH, May 24, 1890.

BOSTON.

Dinner by the Boston Electric Club to the Electrical Engineers—A Trip over the Electric Roads—Consumption of Gas and Electricity —Consolidation of Gas and Electric Companies—Regulation of Overhead Wires.

THE most important electric event of the past week was the visit of the American Institute of Electrical Engineers to this city. A full report of their sayings and doings will be found in another column. In the evening of Wednesday, the first day of their visit, the Boston Electric Club had the honor of entertaining the members of the Institute at dinner at the Parker House, when there were present about 180 members and guests, making it by far the most important gathering ever held under the auspices of the Club. Mr. S. E. Barton read a paper on the "Relation between Fire Insurance and Electric Interests from the Underwriters' Standpoint," which was much enjoyed. The dinner itself was the best which the Club ever gave, and the proprietors of the Parker House have every reason to feel satisfied at their success. After Mr. Barton's paper, there was considerable speech making on various topics, the discussion of the paper having been postponed to another occasion. Mr. Cram, as president of the Club officiated, and introduced in a neat and appropriate manner the gentlemen who spoke. Professor Elihu Thomson, the retiring president of the Institute of Electrical Engineers, as a member of the Institute thanked the Club for its courtesy, and as a member of the club welcomed the members of the Institute as guests. Professor Anthony, the newly elected president of the Institute was next called upon, and made a few remarks relating to the absorbing interest which is manifested in electrical matters. Mr. Ralph W. Pope, gave a humorous outline of the programme for the following day, and paid a high compliment to the hospitality of the East. Mr. L. S. Dumoulin, of the West End road, then made a few facetious remarks, and invited all the members and their friends to partake of the hospitality of the West End Street Railway Company on the following day. Capt. Griffin related a few humorous anecdotes, and was followed by Mr. C. F. Pritchard, president of the Association of Gas Engineers, who spoke warmly in favor of the close alliance of gas and electric interests. Mr. Joseph Wetzler, of THE ELECTRICAL ENGINEER, which the chairman characterized as the foremost electrical journal of the day, then spoke on behalf of the Electrical Press, and in the course of his remarks deplored the action of the daily press in so often deceiving the minds of the public on electrical matters. Prof. E. L. Nichols, of Cornell University, Senator Metcalf, of the Massachusetts Legislature, and F. L. Pope, made a few appropriate remarks, after which letters of regret were read from Mayor Hart, Gen. Francis A. Walker, and Col. G. H. Campbell.

On the following day, Thursday, a brief visit was made to the rooms of the Institute of Technology, and then, under the able guidance of Mr. Dumoulin and Mr. Mansfield, a visit was made to the Albany street power station of the West End road. Much interest was taken in the massive foundation work for the 1,000 horse-power engines, and the members were all enthused over the careful, and complete drawings of the proposed station, which were ably explained by Mr. F. S. Pearson. Carriages then took the members back to Park Square, where special cars had been provided and a most enjoyable flying trip was made on the electric line to Chestnut Hill, and back to the Parker House, where the West End Company had prepared a most elegant and récherché lunch. In the afternoon a visit was made to the works of the Thomson-Houston Electric Company, and the Thomson Welding Company at Lynn, Professor Thomson himself escorting the party and showing them every courtesy. Altogether the visit of the Institute to Boston was a most successful and enjoyable one, and it to be hoped that another meeting may be arranged to be held in is the East at no very distant date.

The citizens of East Boston are now clamoring for electric cars, and propose to hold a mass meeting for the purpose of inducing the West End Company to comply with their requests.

The new open Robinson radial car has been tested on the West End road this past week and pronounced a success. The arrangement of the trucks has been frequently described, and it seems probable that their use will become general in a very short time.

In an exhaustive circular on the Bay State Gas Co., Messrs. Devens, Lyman & Co. make the following statement, which may be of interest to electrical engineers:—"It is a fact that the use of electric lights increases the consumption of gas, as people become more accustomed to more light and use more, and the consumption of gas as a fuel is also a growing factor in the manufacture of it. The consumption of gas in the city of Boston has increased about 8 to 10 per cent. a year, and is still increasing; therefore, from the above facts there would seem to be no reasonable fear that electric lighting will injure the business of gas companies."

The Suburban Electric Light & Power Co. have filed another petition in the Supreme Court for a writ of mandamus to compel the board of aldermen to allow them to erect electric light poles.

In the Massachusetts Legislature, the house has passed the bill to authorize the consolidation of gas and electric companies, after adopting an amendment to limit the capital of the new company thus formed to the amount of the stock already issued by the companies which consolidate.

An extended debate occurred on the bill relating to the regulation and supervision of wires over streets or buildings in cities. Mr. Stearns, of Salem, opened the discussion by moving a long series of amendments, sweeping in character, making the bill apply to all cities of 50,000 or more inhabitants; that the wires shall be suitably insulated; that the bill shall apply to all overhead wires; that street railway power wires shall not be insulated, and that the powers of the wire supervisors shall be enlarged. Mr. Means, of Boston, said the proposed amendments, if adopted, would kill the bill. He moved to amend by providing that fuses should be placed at such points in the electric circuit as should effectually protect buildings from fire, instead of having them indiscriminately placed at all points of entrance. All the amendments offered by Mr. Stearns, of Salem, were rejected, Mr. Means' amendments adopted, and the bill was passed to be engrossed by an almost unanimous vote.

BOSTON, May 24, 1890.

In the United States Circuit Court at Boston, on May 21, the time for taking testimony in the case of the United States against the Bell Telephone Company was extended to Oct. 1, the court ordering that no testimony be taken from July 15 to Aug. 30, inclusive. This extension was asked by Mr. Roberts, who has charge of the case before the examiner, because the condition of his health necessitated a vacation during July and August.

LEGAL NOTES.

CLAIMING THE INCANDESCENT LAMP.

WALTER K. FREEMAN vs. THE U. S. ELECTRIC LIGHT CO.

Before Judge Ingraham in the New York Supreme Court, on May 22, trial was begun of a suit brought by Walter K. Freeman against the United States Electric Lighting Company. In his complaint, Freeman avers that he invented the incandescent electric lamp prior to August, 1878, and sent a lamp to Edison at Menlo Park, N. J., and that about two years afterward Edison announced the invention to the world as his own. He then asserts that Edison offered him $50,000 if he would refrain from mentioning the fact that he was in reality the inventor and had sent sample lamps to Edison.

The lamp he claims to have sent to Edison embodied all the features of the Edison lamp, consisting of a carbon filament of high resistance secured to platinum wires and enclosed in a glass globe from which the air had been exhausted.

Freeman now claims a residence in this city, but is connected with a business at Eau Claire, Wis. He was at Racine in 1878, when he sent the lamp, as alleged, to Edison, and was subsequently taken into the employ of the defendant company during a part of the year 1882.

He brings his suit against the United States Electric Lighting Company, alleging that a written contract was made with that company in June, 1881, which provided that if a patent were obtained on Freeman's alleged inventions which should be superior to the patent which Edison had at that time obtained, the company should have the option of taking it or paying him $100,000. No patent was granted, and he claims that the company was derelict in pushing the claim. He lays his damages at $150,000, part of which is for salary due for failure of the company to continue him in its employment.

It is contended by the defence that the contract was not made for the benefit of the company, that the defendant made the application to the Patent Office in his own behalf, and that his application was rejected as invalid.

It is further claimed that Freeman secured the contract by false representations and pursuant to a scheme of fraud to get money and employment without giving anything of value in return.

DENIAL OF A WRIT OF ERROR TO KEMMLER.—OPINION BY CHIEF JUSTICE FULLER, U. S. SUPREME COURT.

At Washington on May 23, the Supreme Court of the United States denied the application for a writ of error in the case of Kemmler, under the sentence of death by electricity. The opinion is by Chief Justice Fuller. It first recites the proceedings in the lower courts leading up to the bringing of the case to this court. The Court says that it is urged in Kemmler's behalf that the fourteenth amendment is a prohibition on the State of the imposition of cruel and unusual punishment, this being included in the term "due process of law." The origin of the phrase "cruel and unusual punishment," the Court said, was in the English Act of Settlement of 1688, and meant that barbarous methods of punishment should not be inflicted. It meant that a man should not be sentenced to death by torture, but did not mean that the death penalty itself was cruel. The New York Court of Appeals, the opinion says, held that the punishment inflicted on Kemmler was unusual, but that there was no evidence to show that it was cruel. The Legislature of New York had the facts bearing upon this question, and the Court must presume that the Legislature had devised a punishment it thought less cruel than the former mode. That decision, the Court says, was not against any special privilege set up by the prisoner, and was so plainly right that the Court would not be justified in overruling it.

The Fourteenth Amendment did not materially change the whole theory of the Government. Citizens still remain citizens, both of the State and of the United States. The only change is that the amendment furnishes an additional guarantee against encroachment by the State upon the fundamental rights of the citizens. The privileges and immunities of citizens of the United States are, indeed, protected by them. Those are the privileges arising out of the essential nature and character of the national Government.

The Court quotes the opinion in the Hurtade case on the meaning of the phrase "due process of law." The change in form of death was within the legitimate sphere of the legislative power of the State. The Legislature of the State of New York determined that it did not inflict cruel and unusual punishment, and its courts have sustained that determination. This Court cannot see that the prisoner has been deprived of due process of law.

In order to reverse the judgment this Court should be compelled to hold that the Court of Appeals had committed an error so gross as to deprive the prisoner of his constitutional rights. The Court has no hesitation in saying it cannot do this.

INVENTORS' RECORD.

CLASSIFIED LIST OF UNITED STATES ELECTRICAL PATENTS.

Issued May 20, 1890.

Alarms and Signals:—*Electric Signal-Circuit*, O. W. Hart. 428,095. *Electric Semaphore Apparatus*, F. Stitzel and C. Weinedel, 428,576. *Watchman's Time-Recorder*, C. E. Egan and H. F. Gray, 428,583.

Conductors, Conduits and Insulators:—*Elevated Conduit for Electric Wires*, H. N. Ruttan, 428,145. *Electric Insulator*, E. Andrews, 428,545.

Distribution:—*Electrical Converter*, W. Stanley, Jr., 428,574. *Method of Building Electrical Converters*, W. Stanley, Jr., 428,575.

Dynamos and Motors:—*Commutator-Brush for Dynamos*, L. Van Brown, 428,073. *Electric Motor Regulator*, W. H. Knight, 428,169. *Armature for Dynamos*, A. Schmid, 428,289. *Regulator for Electric Current Generators*, G. Pfannkuche, 428,317. *Dynamo-Electric Machine or Electric Motor*, E. Croasdale, 428,380. *Electric Motor*, W. H. Chapman, 428,454. *Electric Motor or Generator*, H. Groswith, 428,481.

Galvanic Batteries:—*Galvanic Battery*, A. J. MacDonald, 428,116.

Ignition:—*Electric Gas Lighter*, R. T. Walton, 428,433.

Lamps and Appurtenances:—*Arc Lamp*, C. F. Breese, 428,066 *Device for Elevating and Lowering Electric Lamps*, J. B. Morris and G. Voll, 428,401. *Alternating Current Arc Lamp*, Geo. Westinghouse, Jr., 428,435.

Measurement:—*Electric Meter*, A Frager, 428,084. *Electric Meter*, J. F. Mehren, 428,280. *Electric Meter*, E. W. Von Siemens, 428,290.

Metal-Working:—*Electric Furnace for Melting Metals*, E. A. Colby, 428,378. *Process of Welding Metals Electrically*, C. L. Coffin, 428,459. *Process of Melting, Refining and Casting Metals*, E A. Colby, 428,552.

Miscellaneous:—*Process of Electro-Deposition*, D. Garrett, 428,087. *Magnetic Lock*, W. W. Fenner, 428,247. *Magnetic Lock*, J. Schneider, 428,256. *Graphophone*, M. L. Deering, 428,273. *Electric Induction Device*, E. A. Colby, 428,379. *Voltaic Armor*, A. L. Scott, 428,420. *Electrical Heater*, J. I. Ashbaugh, 428,443. *Electric Bath-Brush*, R. E. Williams, 428,540. *Electrical Cut-Out*, W. J. Jenks, 428,564.

Railways and Appliances:—*Insulator for Electric Railway Wires*, H. P. Brown, 428,071. *Trolley System for Electric Railways*, H. P. Brown, 428,072. *Electric Railway*, R. M. Hunter, 428,098. *Trolley-Arm Support for Electric Railways*, F. B. Rae, 428,136. *Electric Locomotive*, J. F. McLaughlin, 428,175. *Electric Railway*, R. M. Hunter, 428,210 and 428,211. *Electric Railway*, J. B. Legg and J. Nill, 428,499. *Electric Communication with Railway Trains*, T. J. Houck, 428,562.

Telegraphs:—*Synchronous Multiplex Telegraphy*, F. J. Patten, 428,221, 428,224, 428,225 and 428,226. *Multiplex Telegraph*, F. J. Patten, 428,222. *Multiplex Telegraphy*, F. J. Patten, 428,223.

Telephones and Apparatus:—*Telephone*, J. G. Ludwig, 428,174. *Three-wire Multiple Switch-Board System*, E. P. Warner, 428,189. *Registering Attachment for Telephones*, R. J. & J. S. Storey, 428,427.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"SAFETY" CABLES IN THE NEW YORK SUBWAYS.

Mr. L. E. Requa, the general manager of the Safety Insulated Wire & Cable Co., of 234 West 29th street, this city, has in his possession an interesting letter from the late D. L. Gibbens, subway commissioner, written a few days before his death; we give the complete text of the letter below as follows:

New York, April 17, 1800.

Dear Sir:—In reply to your inquiry concerning the use of the cable manufactured by your Company in the subways in New York City and known as the "Safety Cable," I would say that it is within my knowledge that over one hundred miles of this cable has been in constant operation for electric lighting purposes in the said subways for periods ranging from two months to over one year, and during that time not a single defect has been reported, nor have there been brought to my knowledge any trouble or fault in such cables whatsoever. There have been two instances where, owing to careless workmanship and mechanical injury, defects have been occasioned, but these were not the fault of the manufacturer of the cable nor were they due to any inherent defect in the insulation used, or the method of manufacture. The very remarkable and senseless opposition of many electricians to the employment of underground wire for electric lighting prior to the successful tests made in the subways in this city took the form of a prophecy that underground wire for the purpose of conducting electricity for high tension lighting and power circuits would surely fail. The success of the cable manufacturers in meeting the question was most gratifying to the members of the Board of Electrical Control and undoubtedly will be so to the public generally when the facts are fully understood. Much of the confidence which is felt in the success of the underground service is undoubtedly due to your excellent work.

Yours very truly,
Daniel L. Gibbens,
Ex. Com. Board of Electrical Control.

It is worthy of note in this connection that Mr. Wm. Maver, Jr., the electrician of the Consolidated (subway) company, has made some tests on lead covered "Safety" cables made and laid for the Mt. Morris Electric Light Co., in this city, with the object of determining the effects of high temperature on the insulation of cables lying near the steam heating mains.

Wednesday, March 26, 1890, 2.30 p. m. Location of testing place, Duane street near Broadway (basement plumber's shop.) Constant 25,000 megohms.

First Test—Conductor A, No. 6 B. & S. In subway from Duane to Beaver street, Broadway. Total insulation resistance after one minute electrification, 1,250 megohms. Estimating length of conductor as 8-10 mile, insulation resistance per mile, 1,000 megohms.

Second Test—Conductor B, No. 2 B. & S. In subway parallel with conductor A, from Duane street to Beaver. Total insulation resistance after one minute electrification, 1,250 megohms. Insulation resistance per mile, 1,000 megohms.

Third Test.—Conductors A and B tested together. Length 1.6 miles. Total insulation resistance after one minute, 625 megohms. Insulation resistance per mile, 1,000 megohms.

Fourth Test.—Conductor C, No. 2 B. & S. In subway from Duane and Broadway to 14th street and 6th avenue. Estimated length, 2.2 miles. Total insulation resistance after one minute, 833 megohms. Insulation resistance per mile, 1832.6 megohms.

Fifth Test.—Conductor D, No. 6 B. & S. In subway from Duane to Houston streets. Estimated length, .75 mile. Total insulation resistance after one minute, 2,500 megohms. Insulation resistance per mile, 1,875 megohms.

Sixth Test.—Conductors C and D tested together. Estimated length 2.95 miles. Total insulation resistance after one minute, 625 megohms. Insulation resistance per mile, 1,843 megohms.

Seventh Test.—Conductors A B C D, tested together. Estimated length, 4.55 miles; 1.6 miles of same in heated district. Total insulation resistance after one minute, 312.4 megohms. Insulation resistance per mile, 1,421.8 megohms.

Tests closed 4.45 P. M.

Conductors A & D will be joined up as part of one circuit, B and C as part of another.

"The temperature in some of the manholes," says Mr. Maver, "has been found by actual measurement to exceed 150 deg. F. The results of tests show an insulation resistance of all the conductors much higher than is required by the subway rules. The conductors have been in the subways, heated districts included, a sufficient time, in my opinion, to develop any tendency to a marked fall in the insulation due to increased temperature if such fall were to follow the placing of the cables in the heated area."

THE McCREARY ELECTRICAL SPECIALTY COMPANY.

Mr. A. A. McCreary, has issued a circular to his friends and the trade in which he says:

"I beg to announce the incorporation of The McCreary Electrical Specialty Co., successors to me in carrying on the business of manufacturing and placing upon the market patented electrical specialties. In addition to my well-known reflectors and half shades, I have acquired the sole control of several valuable electrical patents that I shall take pleasure in calling your attention to in a few days when they will be ready for the market."

The business of the company will be carried on at 18 and 20 Curtlandt street. Mr. McCreary is the vice-president and general manager of the company and Mr. C. C. Foster secretary and treasurer. The favorable reception already accorded to Mr. McCreary's specialties awaits the novelties he will shortly bring to notice.

R. D. WILSON & COMPANY.

Messrs. R. D. Wilson & Co., whose office is at 113 Devonshire street, Boston, are making a specialty of electrical securities, and though organized only about two years ago, are very widely and favorably known as exploiters of electrical stocks. Every stock which they have yet handled has become successful. They were the first to exploit the Thomson-Houston and the Thomson Welding stocks before they were put on the board. They are now devoting a large part of their time to the successful pushing of the New England Printing Telegraph Company, and are offering a limited number of the shares of this company at a very reasonable rate. This company is the licensee for the New England States of the Essick Printing Telegraph, which is creating quite a sensation amongst electricians and capitalists, all being very favorably impressed with it. Messrs. R. D. Wilson & Co. are recently in receipt of the following letter from Prof. Moses G. Farmer, whose opinion is extremely valuable:

At your request I have examined the working of the 'Essick Page Printer,' on a line from New York to Boston. I am highly pleased. I may frankly say that I came here prejudiced, and did not expect to see what I have seen here to-day. The instrument did its work well, and I see no reason why it is not practical for commercial purposes. I have examined the mechanical and electrical features, and find it simple and inexpensive in construction. I see in it new electrical features which are certainly very valuable. I see no reason why the system is not thoroughly practical for all telegraphic purposes, and I believe that the system is all that the inventor claims for it.

BRUSH LIGHT AND POWER PLANTS.

The Brush Electric Company, of Cleveland, O., are equipping central stations with their alternating apparatus as follows: Jeffersonville, Ind., Electric Light Company, 600 lights; S. & J. C. Atlee, Fort Madison, Iowa, 1,000; Red Bank, N. J., Electric Illuminating Company, 1,000; Marysville, Cal., Coal Gas Company, 1,000; Evansville, Ind., Gas and Electric Light Company, 1,000. For arc lighting stations they have sold the Hampton, Va., Electric Light Company apparatus for 30 lights, and one for 100 to the Haverhill, Mass., Electric Company. Isolated arc plants have been sold to J. P. Witherow & Co., New Castle, Pa., 30 lights; Cleveland Rolling Mill Company, 30 lights; Michigan Agricultural College, Lansing; C. S. Robinson, Princeton, N. J., and steamboats owned by R. D. Blair, Osceola, Miss., and St. Louis and Mississippi Valley Transportation Company. Brush motors have been furnished to Princeton College, N. J., and Beecher Furnace Company, Cleveland; an isolated power plant to the Dayton, Tenn., Coal and Iron Company; also a motor for hoisting purposes at Aspen, Col., of the new 440 volt constant potential type; a plating dynamo to the Taylor and Boggis Foundry Company, of Cleveland.

WESTINGHOUSE ELECTRIC STREET RAILROAD FOR LANSING.

Lansing, the capital of Michigan, is to have a model electric street railway, built by the Westinghouse Electric Railway Co. The Westinghouse people guarantee that every road will be a model to which prospective builders can confidently refer for perfection of system in every detail, with the knowledge that every part will be of the latest and most approved pattern known in electrical science. The road will be pushed to completion at once.

THE McDOUGALL-MARTIN ELECTRIC COMPANY.

During the next fortnight the McDougall-Martin Electric Co., of 120 Times Building, this city, will demonstrate the practicability of the storage battery system in connection with the McDougall motor which has been specially constructed for that purpose. This car will make 50 miles on a single charge of battery and will, beyond doubt, excite considerable interest and attention in electrical, street railway and other circles.

EUREKA TEMPERED COPPER.

In a letter of May 14, to the Eureka Tempered Copper Co., of North East, Pa., Mr. C. R. Huntley, the general manager of the Brush Electric Light Co. at Buffalo, N. Y., says:

"Some time about eight months ago we began the use of tempered copper for commutator segments on the Brush machine, and we have had remarkable success with its use. We find that they wear about three times as long as ordinary segments made of copper. We have tried the experiment of using tempered copper for brushes and beg leave to report the result. The 1st of March we put a set of brushes on a dynamo and they were not trimmed until the 17th of April. This is a remarkable showing and you may count upon us as staunch advocates and constant users of tempered copper in this line of our business."

The Jeffrey Manufacturing Co., who make the well-known Jeffrey electric coal mining machines at Columbus, O., write as follows:

"In reply to your favor of the 10th, would say that we are using your tempered copper for bearings on our coal mining machines and find it superior to any metal we have used for this purpose. It is subjected to severe work and stands it splendidly."

NEW WESTINGHOUSE PLANTS.

Owing to the rapid increase in the business of the Brush Electric Company of Baltimore, that organization has found it necessary to increase the capacity of its incandescent plant by the addition of a Westinghouse three thousand light alternate current dynamo. This machine will be shipped immediately and installed at the earliest possible moment.

The Wilmington City Electric Company of Wilmington, Delaware, has for some time been contemplating extensive improvements in its electric light plant owing to the great increase of patronage on the part of the citizens of Wilmington. The company has just contracted for a new 750 light machine, Westinghouse alternate current incandescent system, and no time will be lost in the installation.

The Citizens Electric Light Company of Braddock, Pa., has been obliged to increase the capacity of its incandescent lighting plant. A contract was made with the Westinghouse Electric Company a few days ago to furnish a 750 light alternate current dynamo. This addition will give the company a total capacity of 1,400 lights.

The Westinghouse incandescent light is to be employed at the far famed Bar Harbor on the coast of Maine. The Westinghouse Electric Company has just closed an order with Bar Harbor people calling for twenty two hundred and fifty lights capacity in generating apparatus of the alternate current incandescent type.

Saco, Me., has decided to adopt the Westinghouse alternate current system of electric illumination. The initial plant at Saco will consist of one 750 light incandescent dynamo.

Connersville, Ind., is to have the electric light. An electric light company recently organized at that place has just closed negotiations with the Westinghouse Electric Company for a 750 light incandescent dynamo and two forty light arc dynamos, all machines to be of the alternate current type. Mr. J. W. Huston, treasurer of the United States, is the president of the Connersville company.

The Westinghouse Electric Company has just sold a 750 light dynamo which will be used toward dispelling in a measure the darkness of the town of Chanute in the state of Kansas.

EDWARD R. KNOWLES, C. E.

MR. KNOWLES has opened offices at 181 Broadway, this city, and has issued the following professional announcement: "Permit me to notify you that I have associated myself in business with Mr. Ernest C. Webb, counsellor-at-law and solicitor of American and foreign patents, with offices at the above address. Hereafter I shall transact a general engineering and expert business, making a specialty of all branches of electrical work, in which I have had a practical experience continuously since 1879. I shall also give attention to the experting of patent causes, and the construction and testing of electrical and mechanical machines and devices." Mr. Knowles is well known throughout the electrical profession, both as an engineer and as an inventor. Though still a young man he can justly claim to have been a pioneer in the electric lighting field He has also a close familiarity with the newer branches of electrical engineering. Messrs. Knowles and Webb will be represented in Washington, at the Pacific Building by Mr. F. Carragan. In this city the firm will have a branch office also at 22 Cliff street.

ST. LOUIS, MO., ELECTRICAL SUPPLY COMPANY.

THIS company have purchased the business and stock of the old St. Louis Electrical Company (proprietary) and will carry on the business at the familiar stand, 403 North Eighth street. It is their intention to increase and extend their field of operations and usefulness as much as possible, and they will carry a full line of supplies at all times. Parties desiring to place agencies should correspond with them, and purchasers within their large territory should get quotations on any goods needed The company has a capital stock of $25,000. W. L. Scott is president, J. F. Porter, vice-president, and G. W. Brinck, secretary.

THE ILLINOIS ELECTRIC MATERIAL COMPANY.

AN important consolidation has just been effected in the supply business by Mr. Ernest Hoefer, of Bishop White Core and Trinidad Line Wire fame, Mr. Earnest L. Clark, well known in the "pole" business, and Mr. H. S. Winston. The new company just organized by these gentlemen to do a general electric light and power supply business, has been incorporated under the name of "The Illinois Electric Material Company." The company will push with increased vigor the Bishop White Core wires and other specialties manufactured by that company and Trinidad Line wire made by the Trinidad-Heymann Insulated Wire Co., of New York, for which goods they are the sole western agents. They will also pay especial attention to pole and line supplies. A large stock will at all times be carried, and the quickest possible shipments can be made. The offices of the company are located at room 341 Rookery. We wish this new concern the success which will undoubtedly be attained by men of such well-known ability in the supply business. Mr. H. S. Winston is president and treasurer, Mr. Ernest L. Clark, secretary, and Mr. Ernest Hoefer, vice-president and manager.

THE ECONOMIC ELECTRIC MANUFACTURING COMPANY.

The Economic Electric Manufacturing Company of Brockton, Mass., have made a contract with the Siemens-Halske Company of Berlin for the purchase and sale in the United States of the Siemens-Halske incandescent lamp filament. The Economic Company propose to mount these filaments in lamps and sell them as well as their own filaments, and will thus be prepared to supply lamps of every voltage and capacity in ordinary, commercial use. This in connection with their dynamo and motor service will keep their new factory at Brockton in active operation during the summer months. They will shortly have these lamps on exhibition at their offices at 1 Beacon street. The factory is in charge of mechanical superintendent John H. Vinton, and electricians John G. Hubbard, and Edward A. Clark, with Prof. Hooper of Tuffts College as consulting electrician. Work is now being actively carried on in making new patterns of dynamos and motors, and the fitting up of the lamp department, which will have at the outset a capacity of 500 lamps per day.

NATIONAL ELECTRICAL MANUFACTURING COMPANY.

This company, successors to the electrical department of the New Haven Clock Co., have recently removed to 14 and 16 Vesey street, this city, as noted in our last issue, and have sent out another edition of their large, complete and tasteful catalogue of 122 pages, including a full line of supplies, instruments, time and watchman systems, etc. It will be remembered that the National Co. make a specialty of the Microphone battery and the Crowdus dry battery, for both of which they can show a bushel of testimonials. The company are now preparing for more extensive work and will shortly be in the market with their new products.

ECLIPSE WIND ENGINE CO. OF BELOIT, WIS.

The above company has recently filled large orders for its friction clutches, etc., from the Union Depot Railroad Co., St. Louis and the Laclede Gas Co. of that city. Among other large orders is one for an outfit for the transmission of 3,000 h. p. power for the Louisiana Electric Light and Power Co. of New Orleans; also a second order for a rope transmission from the Detroit Electric Light and Power Co. and one for an equipment doubling the capacity of the Queen City Electric Light and Power Co. of Dallas, Tex.

NOVELTY ELECTRICAL SUPPLY COMPANY.

The Novelty Electrical Supply Co. of Cincinnati, E. P. Morris, president, and P. B. Chaney, secretary, are doing a handsome business in their specialties. They have just made a sale to the North-Western Thomson-Houston Co. of Minneapolis, of 1,000 of their patent insulated pulleys, and have received an order for 800 from the Central Electric Co. of Chicago. They have now in use about 13,000 of their pulleys, all of which have been placed on the market since November last. They are also receiving a great many orders for their arc light windlasses, and recently shipped 50 to this city. They have also made a contract with the Cincinnati Street Railway Co. for 1,350 of their patented combination pole tops, and over 10,000 of their patent insulated trolley hangers. In fact, the entire construction in Cincinnati will be done with the appliances of which they are the inventors and owners.

THE GREAT WESTERN ELECTRICAL SUPPLY COMPANY.

We would direct the attention of our readers to the special announcement of Mr. George Cutter respecting the establishment of the headquarters of this new company at 190–192 Fifth avenue, Chicago.

NEW ENGLAND TRADE NOTES.

The Evans Friction Cone Company has secured a contract to furnish their Evans system of driving for the Waltham Electric Light Company, Waltham, Mass. A 800 horse-power compound condensing Armington & Sims engine will be coupled direct to the line shafting, and six dynamos will be driven from the line shaft by Evans pulleys, two of them being 80 horse-power generators for the Newton Street Railroad. The Evans Company have also fitted their driving system to the Waltham Watch Company's electric plant, and will start up in a few days in the Vanderbilt building, New York, a 450 light Loomis incandescent dynamo, driven by a Fitchburg engine.

The Standard Electric Company, of Vermont, have sold, through their Philadelphia agency, a 500 light incandescent dynamo, to be installed in the new mill of G. C. Hetzel & Co., at Chester, Pa.

Mr. D. C. Spruance, of Lewisburg, Pa., has secured the contract for the erection and the complete equipment of a 1,500 light station at Portsmouth, Va. There will be two 750 light Westinghouse alternating dynamos, two compound Westinghouse engines of 75 horse-power each, and about two and one-half miles of pole line work.

Messrs. J. A. Grant & Co., of Boston, have received an order for the complete steam plant of 800 horse-power for the Kingston Electric Light and Power Company, of Kingston, Jamaica, West Indies. The plant will consist of two McIntosh & Seymour compound condensing engines, two steel tubular boilers, heaters, condensers, injectors, pumps, and all necessary fittings. This is the second plant which Messrs. Grant & Co. have shipped to Kingston, Jamaica.

Pettingell, Andrews & Co. report business becoming quite brisk again throughout New England, and Mr. Levi Cofren, their well-known popular representative, has recently closed contracts for large quantities of supplies for the Worcester, Mass., Electric Light Company, Lowell, Mass., Electric Light Corporation, Nashua, N. H., Electric Light Company, Bellows Falls, Vt., Electric Light Company, and the Middlebury, Vt., Electric Light Company.

Mr. Charles L. Ireson, of Boston, has opened a factory in Atlanta, Ga., for the manufacture of leather belting, and has the honor in so doing of possessing the pioneer belt manufactory of the South. Mr. Ireson's belts are well known in the East, and trade has been so steadily growing in the South that he has taken this important step to give his customers every facility for the prompt delivery of all kinds of oak-tanned belting. Reports from the South state that already important orders have been received, and Southern consumers are extremely pleased to have in their midst a factory where they can have their belts made endless, a feature in belting that appears to have been somewhat neglected in the South. Mr. Ireson has sent some of the most expert of his staff to start the business.

WESTERN TRADE NOTES.

The Ft. Wayne Electric Company, through their Chicago office, sold to Litchfield, Minn., a new Wood 25 arc light plant and 500 incandescent lights of the Slattery system last month; and this month they have sold an increase, so that the complete plant now has 40 arc lights and 1,200 incandescents. The Central Electric Light Company, of Chicago, have ordered an increase of their plant, amounting to an addition of 5,000 incandescent lights. The South Side Electric Company, of Chicago, have placed an order for a 10,000 light plant of the Slattery induction system. Armour & Co. have ordered two 1,200 light incandescent plants of the same system. The Oakwood Electric Light Company have just made the third extension of their plant since starting, by the addition of a 60 light new Wood arc dynamo. The incandescent plant, Slattery induction system, recently installed for the same company, will be started up in this station right away.

Schuyler Electric Co. Mr. Wheeler, the expert of the Schuyler Electric Co. is in town looking after the various plants which have been installed here by his company. He reports business as flourishing and the outlook very bright. It is needless to say that the Schuyler plants are giving the same satisfaction to all here as elsewhere, and it is certain that this excellent system will continue to increase rapidly.

The Dawn Electric Construction Co., 154 La Salle street, who manufacture and deal in electric light supplies are very busy notwithstanding the trouble they have had from the recent strikes. They are making a specialty of electric signs the letters and devices of which are formed by means of incandescent lamps and which are very attractive, presenting a beautiful appearance when lighted up. They also represent the Mather Electric Co., and are selling a good stock of that company's apparatus. They handle all kinds of construction work and carry it out in the most thorough manner.

J. R. McKeand & Co. are the sole manufacturers of the Hesson Furnace Grate, quite a number of which have been installed in Chicago, to the great satisfaction of their users. Their offices are located at Room 343, Rookery, where they will be pleased to have a call from all interested in grates.

W. C. Lyman, manufacturer of steam condensing, vacuum exhaust pipe heads, is quite busy filling the demand for these specialties. The advantages claimed for them are numerous, it being a benefit to all non-condensing engines, particularly high speed, and their employment also tends to preserve roofs, walls, etc., from being rotted by exhaust steam. The escape is dry and noiseless and not attended with any back pressure, and a saving is effected in water of from 25 to 75 per cent., according to the length of the connections, and the different conditions of plants working with wet or dry steam. This apparatus has met with great success, and been very largely employed by electric light and power companies.

The National Engineering Bureau, who are located in the Rookery, are very busy, although but recently organized. They are designing quite a number of central station plants, for which they make the drawings and specifications, and then superintend the work of the construction companies, seeing that everything is carried out in the most thorough and complete manner. They will undoubtedly find a large amount of this class of business. By reason of their tried experience and ability, purchasers of plants who employ them to supervise the work can be assured of its excellence throughout.

The Western Electric Co. have just issued a neat and handsomely gotten up catalogue of their testing apparatus. It is replete with illustrations of the various instruments and contains a full and clear description of the same and their uses. The celebrated Rudd ground alarm, which has met with such universal approval among central station men, occupies a prominent position. In this ground alarm, it will be remembered that the indicator is shown by a drop such as those employed on telephone switchboards, the essential part of the system consisting in the application of condensers. In the catalogue are further enumerated combination bridge set, rheostat and galvanometer, testing set for linemen, magneto bell, and Warner testing battery. Altogether it is a very complete and handy pamphlet.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada, - - - - -	per annum,	$3.00
Four or more Copies, in Clubs (each) - -	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies, - - - - - - - - - - -		.10

[*Entered as second class matter at the New York, N. Y., Post Office*, *April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway*, *New York city*.

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, JUNE 4, 1890. No. 109

I have far more confidence in the one man who works mentally and bodily at a matter, than in the six who merely talk about it.—Faraday.

THE PRICE TO CHARGE FOR CURRENT.

TWO weeks ago we invited the attention of station superintendents to the opportunities that await them in the development of electric power and in the use of electric current alike for stationary motors and for electric railroads. If we may judge from the comments that have reached us, we have started a discussion that is likely to be of lasting benefit.

Some of our friends and correspondents say that their efforts to develop the electric motor industry are checked by the high prices charged for electric motors. They say that prices for such machines are often too high to bring them into an equal competition with water motors, gas motors, small steam engines, and the like. There may be something in this, but we cannot say that the cost of motors strikes us as being much amiss. It is to be borne in mind that a motor needs no boiler, no smoke stack, no steam exhaust, no fuel, no water, and has no ashes to dispose of. There is moreover generally, or should be, a reduction in insurance rates. In view of its convenience and cost of manufacture, the electric motor is to-day a cheap piece of machinery.

On the other hand, the complaint is made to us by motor companies and motor agents that their efforts are offset by the high price charged for current—rates figuring out sometimes $200, $300, and even more per horse-power per year. What is the truth of this? It surely is not good policy to kill the goose that will lay golden eggs. It would rather pay to run the business so that it yielded a larger return from a larger area. This is what the gas companies are doing in the introduction of gas stoves. Thus, for example, Mr. McMillan, of the La Crosse, Wis., Gas Company, has the following plan, to which the gas journals draw attention: Half of the front page of the local *Republican and Leader* has for some time been devoted to a handsomely illustrated advertisement, in which nine well arranged cuts display as many different styles of cooking and heating devices. Stoves to the number of 100 will be virtually given away on the following basis: The purchaser selects the style of stove desired, when the company will set it in place and properly connect it with gas. The stove will be billed at an agreed-on price, and the connections will be charged for at cost. As soon as the bill is paid the gas will be turned on, whereupon the stove becomes the property of the consumer. Gas may then be used for any purpose without charge until the quantity so consumed, at $2 per 1,000 cubic feet, will equal in value the amount advanced for stove and connections, after which bills for gas will be made out at $1.50 per 1,000, and collected monthly in the usual manner.

Now, how would some such scheme work in the way of developing the demand for electric power? We believe there is something in it. and that a great many of our readers will yet reap a large profit by developing a plan of this nature. It will be noticed that the consumer becomes the owner of the stove. It seems that the right plan also is for the consumer to own the motor. He will then take care of it.

CURRENT AND TRACTION.

WE publish in this issue a contribution by Mr. E. E. Ries on a subject which has recently been discussed in various articles in our columns and the importance of which leads us to devote the space accorded to it. The influence of the passage of the current between wheel and rail upon the coefficient of traction has undergone considerable experiment and study by Mr. Ries; some of the practical results obtained by him are in the direct line of application to railway service. The increase of traction observed with wet and oily rails seems an especially valuable feature in this connection. Mr. Ries also states as the result of his observations that high electromotive force has a tendency to diminish friction, but he gives no reason to account for the phenomenon. If such is the case, it would be interesting to determine the cause, as the principle might be applied in some useful way.

AUTOMATIC ELECTRIC WELDING.

IF the predictions that were at one time made regarding the future applications in the mechanic arts of electric welding may to some have appeared visionary, the actual results obtained to-day must be conceded to have completely verified and justified the prophecy. The members of the American Institute of Electrical Engineers were given an excellent opportunity of satisfying themselves on this point by the exhibition made by Mr. H. Lemp, Jr., after the reading of his paper, which appears elsewhere in this issue; and the visit to the works at Lynn increased their admiration for the distinct progress which was there shown. Mr. Lemp's paper may be said to bring the record of the state of the art down to the present day, and is replete with interesting facts, which have not heretofore been brought out regarding the new processes, and the complete study of which alone made the automatic welding machine a possibility. Not the least interesting details are the description of the various types of transformers employed, and the alternating dynamo with "cubic compounding," by which a constant heating effect is obtained independent of the cross-section and length of the specimens to be welded.

Running Plants By Taxation.

ATTORNEY-GENERAL WATERMAN of Massachusetts, has sent communications to the State Senate and House of Representatives on the question raised by them whether cities and towns have the right to construct and maintain lighting plants. He says that under the provisions of the constitution of the commonwealth they have no such powers, and that any act of the Legislature conferring them would be void. It is said that this decision, since it has been contradicted by the Massachusetts Supreme Court on a similar appeal, will not check the movement in Danvers and elsewhere; but if the discussion settles down to voting on a constitutional amendment, we do not believe that the scheme of the Nationalists, with all that it implies, will go through. It opens too wide a door to corruption and jobbery in municipal affairs.

Primary Batteries at the Paris Exposition.

IN his report on the Electrical Exhibits at the Paris Exposition, which we continued recently, Mr. Hering took up the subject of primary batteries and described a number of cells of recent design. Principal among these was the Renard battery, of which we gave some account recently and which Mr. Hering treated at considerable length on account of its novel properties. While designed especially to be used in connection with balloon propulsion and shown to be the lightest cell for a given power thus far produced, even its inventor expresses his doubts whether electrically-driven balloons will ever be successful implements of war if dependent on primary batteries. He referred evidently to the lack of capacity of any primary cell which has thus far been devised, thus naturally limiting the traveling distance of the balloon. The solution of the difficulty might possibly be found in the application of a storage battery, which, of the same weight as the primary cell, would be able to deliver several times the output of the latter. Such a battery would evidently not only solve many of the difficulties met with in ballooning, but would have a marked influence on electrical propulsion both on land and water, as well as in the unpreempted air.

Electrical Properties of Rarefied Air.

We printed recently the results of the experiments of Dr. James Moser, of Vienna, on the electrical properties of rarefied air, which are calculated to recall vividly to the mind of the student the phenomena observed in gases, and which may play an important part in practical applications. Experiments on the specific inductive capacity of air and other gases were made by Faraday and Harris, who arrived at the results again brought out, that, practically, no difference exists in this value, whatever the nature or degree of rarefaction of the gas employed. Dr. Moser's double-bottom Leyden jar recalls also, not less forcibly, the spherical air condenser of Faraday, with which all his experiments were made.

Electricity In the Bermudas.

WE are enabled to give in this issue some early and timely information in regard to the new Halifax-Bermuda cable, whose importance as one link in a long chain is not yet realized; and we are able to supplement that by some interesting data on electricity in general in the Bermudas. Not a few American electricians now visit that part of the world in winter, and, as one of them, Mr. A. Livingston Bogart, who has recently returned, makes a very bright, chatty and newsy report of what he saw. Mr. Bogart's article brings out two facts, one being that the West Indies generally are subject to peculiar conditions, and the other that no matter what those conditions may be, American electrical manufacturers are fairly entitled to look for good markets all through the Caribbean and adjacent waters or main land. It is pleasant in following Mr. Bogart's graphic descriptions to see how the islands are awaking to new conditions of life and prosperity.

Ventilating Steamship Fire-Rooms.

GREAT complaint is being heard just now among roasted firemen on steamers and men-of-war; and it has been suggested that a remedy would be found in the use of blower engines. We believe, however, that the true remedy can be found in the use of electric motor blowers. Every modern passenger steamer has its electric light plant, and there would be no difficulty in running such blowers, especially as the motors themselves can be placed in any desired position, and are so small as to occupy practically no space that is valuable. In fact it seems to us that there is a large opportunity for electric motors generally in marine work, whether aboard the ship for a variety of purposes, or at the wharf for such work as loading and unloading. We are glad to see that in the U. S. Navy, the use of electric motors has already begun to be appreciated.

The Utilization of Counter-Electromotive Force.

DYNAMIC induction in its various phases plays a prominent part in the practical applications of electricity to-day but we are apt to lose sight of or forget the variety of the forms in which it is applied, and it is well to be occasionaly reminded of them. Acting evidently on this idea Mr. T. D. Lockwood has presented to the Institute a paper treating of one of the most important of the phases of dynamic induction, viz., the counter-electromotive force of self-induction The prominent part which the latter plays in all alternating current apparatus, whether it be the telephone or the converter, is apparent and its utilization in economical regulation of alternating current apparatus is well brought out. Mr. Lockwood's exhaustive historical researches are well known, and in this paper he brought out a number of historical facts of interest and value, evincing a patience in research and a keenness of perception that did him infinite credit.

ELECTRICAL MATTERS IN THE BERMUDAS.

BY A. LIVINGSTON BOGART.

Much has been written and told of the beauties of this group of coral islands—of its crystal clear waters, with their lovely tints from lightest blue through varying shades to purple; of its tropical vegetation and surface covered with flowers of gorgeous hues the year through; its hundreds of dead-white houses, splendid cement-like roads without a suspicion of dust, and above all things, its equable climate without extremes of heat or cold. Experience teaches that nothing so said requires qualification, and the American public have for a number of years flocked to its shores by the hundreds, either to escape the rigor and discomforts of our winters and early springs, or to seek recuperation and rest from overwork.

Notwithstanding its natural beauties, advantages and glorious climate, however, the conservative slowness of its people, apparent lack of energy and absence of means of communication with the outside world have stunted its growth and kept it a quarter of a century behind its nearest neighbors. The thought of being cooped up in 30 square miles of territory, however lovely, in the middle of the ocean, 500 miles from the nearest land, with no mode of communication or egress other than a line of steamers plying only weekly for six months of the year and semi-monthly the rest, has been sufficient to shut out thousands of visitors and capital. If it be considered that the inhabitants are not only dependent upon these steamers for every pound of fresh meat, ice, butter and other luxuries, but that, further, not a single spring, well, or drop of fresh water is obtainable upon these islands other than that produced by showers and stored in cisterns; the apprehension of the timid must be pronounced not without foundation. The absence of telegraphic communication is all the more paradoxical when it is recollected that this is a great British naval and coaling station, with one of the largest floating dry-docks in the world and a large military garrison, and that the prosperity of the inhabitants is almost entirely dependent upon its export of vegetables, such as onions, potatoes, beets and tomatoes, which amounted in 1889 to over $260,000. They are thus cut off from that most vital necessity, the knowledge of current prices and present demand.

A new era is opening for the Islands, however. The people have become awakened to what is going on in the world about them, and great improvements are on the eve of being accomplished. New and modern buildings are projected, the channels are to be dredged so as to admit the largest craft, commodious and substantial docks or wharves are to be built, and commerce with the world invited. That which promises most and which is the present principal topic of conversation is the telegraphic cable connection with Halifax. It has passed the date of hope and speculation and within one month will be an accomplished fact. The cable is not to be put down by the British government as first anticipated, but is the private venture of an English joint stock concern known as "The Halifax and Bermudas Cable Company, Limited," its office being at 33 Old Broad street, London. The capital of the company consists of £120,000 in 4½ per cent. first mortgage debentures, and £50,000 in ordinary shares of £5 each. Sir Alexander Armstrong, K. C. B., is chairman of the board of twelve directors; Mr. Otto Rochs, the general manager. The company has contracted with the well-known firm of W. T. Henley & Co., of London, who have manufactured the cable and supply the vessel to lay it. For this purpose the steamship "Westmeath" has been specially fitted with tanks, machinery and instruments, together with the iron huts to be used at each end of the line, they to be erected at the landing of the shore cables. The "Westmeath" is now on her way to Halifax with 874 knots of cable on board, and on her arrival will immediately proceed to Bermuda, laying the line. The expedition will be under the charge of Captain Stiffe, of the Indian navy, acting for the contractors, Mr. R. Peake being on board representing the Cable Company.

The S. S. "Westmeath" sailed from London on the 22d ult. with the cable to connect the two points above named. The "Westmeath" is not a regular cable ship but has been fitted up for the work by the contractors, the W. T. Henley & Co., who have utilized the tanks and cable machinery taken out of the "Roddam" after that vessel had completed the laying of the French West Indian cables.

The "Westmeath" is a vessel of about 3,000 tons register. She is expected to arrive at Bermuda about June 1st and after landing the stores for the equipment of the Bermuda station, will land the shore end there and pay out a short distance seawards. The cable will then be cut and buoyed and the "Westmeath" will proceed to Halifax, taking soundings on the way. A line of soundings on this route was made by the "Challenger" and deep water with level bottom was encountered, so that the work of the "Westmeath" will be chiefly confined to making an accurate survey of the ground at each end of the line; that is from Bermuda into deep water, and approaching Halifax, from deep water to the edge of the Labrador bank.

At Halifax, where the "Westmeath" will probably arrive some time in the second week of June, the northern shore end will be landed and the ship will start paying out toward Bermuda. It was originally intended to proceed the other way about, laying from Bermuda up to Halifax, but owing to the prevalence of fog at this time of year it was decided that there would be risk of delay, as searching for a cable buoy in a thick fog would be worse than looking for a needle in the proverbial bundle of hay. According to the present plan of operations, although the ship may start in foggy weather, she will soon steam into sunnier climes. It is estimated that, all going well, the work of laying the cable will occupy some six or seven days, so that communication with Bermuda should be established before the end of June.

The cable conductor consists of a strand of seven copper wires, 120 lbs. per knot, insulated with three alternate coatings of gutta percha and Chatterton's compound, 150 lbs. per knot. This core is covered with a serving of jute yarn steeped in "cutch" or preservative mixture applied wet, and then whipped with three-thread jute yarn to keep the serving in place. The deep sea cable is served with 16 No. .099 galvanized homogeneous iron wire. The "intermediate A" is sheathed with 12 No. 8 (B. W. G.) and "intermediate B" with 12 No. 5 wires. The shore end consists of "intermediate A" sheathed with twelve strands of three No. 6 wires. The whole of the above is served with two coats of Russian hemp, laid on in opposite directions, and three coatings of bituminous compound, the first of which is put on next to the wires, and the others over a layer of yarn.

The approximate weight of shore end, intermediate A, B, and deep sea cables, is 14, 5, 3 and 1 tons per knot respectively. The conductor resistance is 10.5 ohms per knot at 75 degrees Fahrenheit. The gutta percha resistance after 24 hours immersion in water at 75 degrees is to be not less than 1,000 megohms per knot after one minute's electrification. The instruments to be employed are the modified form of syphon recorder.

Although the Cable Company receives a subsidy of £8,100 per annum for twenty years, it is not a government line, but will be opened for general commercial business daily from 8 A. M. to 8 P. M., and the greatest amount of traffic is anticipated between New York and Bermuda; but it cannot but prove of the utmost service to the merchant marine of the world, making Bermuda a calling port for vessels plying between Europe, the West Indies, Gulf and South America. Arrangements are now being negotiated with all American, Canadian and European lines for a general interchange of business.

This entire work is being performed under the direction of the well-known cable engineer, Mr. Joseph Rippon, who is the superintendent of the electrical affairs of the Halifax & Bermudas Cable Co., and who will remain in full charge of the plant with headquarters at Bermuda. This gentleman has fully completed all arrangements for the landing of the cable, erection of huts, etc., at both ends of the line, and is now at Bermuda, where he will join the cable steamer "Westmeath," in order to be present at all the operations connected with the laying down of the cable.

Mr. Rippon, who is a native of Yorkshire, England, although but 36 years of age, has had a most extended experience in this class of engineering work, having been connected with the laying, repair or surveys for some of the most notable cables put down during the last twenty years, as the following short summary of his work will show:

1870 to 1880 in India and Brazil, laying the Western and Brazil cables; 1880, laying cables in the Gulf of St. Lawrence and Bay of Fundy; 1881, cables in the Mexican Gulf and survey for cable between Demerara and Para; 1881 to 1882, Central and South American cables in the Mexican Gulf and Pacific; 1883, repairs of the two "Lizard-Bilbao" cables. The same year he took up the instrument department of the Silvertown Telegraph Works, for which company he had undertaken all of the above expeditions from 1880, the Silvertown Works having manufactured all of the cables therein used. In 1887 he laid the two first Chinese cables between Formosa and the mainland, for the Silvertown Company, they supplying cable, ship and all fittings. In 1888 he was engaged in laying West African cables.

Mr. Rippon, to whose courtesy I am indebted for much of the information here given, is much interested in the "Burke" Cable-Relay, and informed me that he intended to give it a test on the new line at an early date.

Although the line here described is of the utmost value to the business world, it pales in significance before the far-reaching results embraced in the projected extensions of the system which I understand are to be pushed at an early date. Thus, the line is to be prolonged westward from Bermuda to Nassau and Jamaica, and thence to the mainland at Progreso and Vera Cruz, tapping lines to all parts of the U. S., from the south. On the other hand an Eastern prolongation from Bermuda will be laid to the Azores and thence to Lisbon, Portugal, thus making connection with England and Africa.

The Island since 1887 has been provided with a most efficient telephone central system service. The stations are three in number, Somerset, St. George's and Hamilton, the latter being the main station. The subscribers are 152 in number, of whom 114 are in Hamilton. No toll system is used, the rental per year being £6 for business, and £8 for private purposes. There are only three dead head instruments, these being at the government buildings. The system includes 400 miles of wire, with 700 feet of submarine cable; No. 9 wire is employed on the two trunks and No. 12 on short lines. The construction is the same as that commonly employed in the States. All of the construction material, such as poles, insulators, wires, etc., as well as transmitter batteries, has been supplied by The E. S. Greeley & Co., of New York. The central station at Hamilton, although rather small, is neatly fitted up. It is supplied with a Western Electric switchboard for 150 wires, in three sections of 50 each. Two of the sections were supplied by the Tropical American Telephone Co. (who have also furnished the telephones, transmitters, etc.), and the third by the Antwerp Western Electric Co.

The lines are open for business from 6 a. m. to 10 p. m., and from the opening of the main office until the present time there has been no interruption to business. The longest circuit operated is 25 miles. There is no induction trouble on any of the short lines, and on the long 12 mile lines it is so slight as in no way to affect the service, although the telephone wires run for miles parallel with the telegraph, and in some instances on the same poles.

No trouble has been experienced as yet from oxidation of wires, although lines running along the water side on the south coast are beginning to show signs of being attacked. The lines are put up in a most substantial and neat manner, all joints being soldered. The greatest difficulty which has been met with has been in the matter of obtaining grounds, the island being porous coral rock, and no water existing except such as is found in the cemented cisterns, the rain being the only supply for either drinking or washing purposes. As a consequence the curious method resorted to for obtaining a ground is by dropping a coil of wire in the subscriber's cemented cistern, with the exception of the principal street of Hamilton, which has a pole ground wire, the ends connected to plates sunk in the harbor.

The switchboards are never deserted on account of lightning, none of the offices having ever been affected or anything burnt out on them from such cause, and during the three years that the system has been in operation, only six subscribers' coils have been destroyed.

The efficient service, general satisfaction and financial success of the system is entirely due to the ability, zeal and untiring industry of the genial managing superintendent and electrician, Mr. R. A. Ferguson, who not only designed and laid out the system, but personally erected the entire plant. He relates some very amusing episodes of his experience in putting up the lines when assisted by his corps, consisting of three colored men, the first deaf, the second lame and the third blind. Mr. Ferguson is a nephew of Mr. Alexander McCay, the president of the Anglo-American Telegraph Co., and a brother of Mr. James Ferguson, the superintendent of the Municipal Electric Light Co., of Brooklyn, Mr. R. A. Ferguson having left the service of the same company to assume the superintendency and build the Bermuda telephone system.

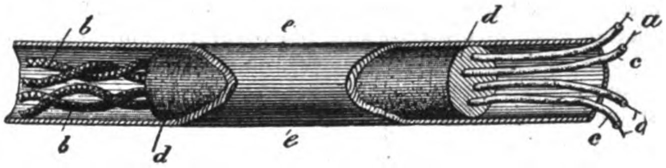
The post-office system of the Island includes a government telegraph having some 11 offices, which are open to public service, although in reality it is a military line. There are 32 miles of No. 8 wire employed in all on double mushroom double-glazed porcelain insulators, with iron bracket pins on cedar poles. The instrument used is the English military sounder with club-handled key, worked on the open circuit system, each office being supplied with 24 old style small sized French Leclanché batteries. Owing either to poor cells or bad insulation the instruments work very faintly. In sending, the operator's sounder is out of circuit and he is dependent upon a curious little upright galvanometer in a cylindrical case upon the sounder base, which acts most sluggishly. The cut-out is rather an amusing sight for Yankee eyes, consisting of a chunk of iron weighing quite ten pounds, which ordinarily rests upon a similar one, although insulated from it, acting normally as a lightning arrester. When it is desired to ground either side of the operating station, the upper block is lifted by a handle and slid down so that its surface rests against the lower block, thus making the ground. Two sets of these are used at each looped station.

No electric lighting is done on the Island. Both of the Quebec Company's steamers the "Trinidad" and "Orinoco" are fitted throughout with incandescents, the system being the "Mather." The work on board has been done in England and has given no trouble whatever since installment. The majority of lamps used are the English Swan. The speed of armature on the "Trinidad" is only 600 revolutions, the light brilliant and steady; the machine is slowed down after 11.30 p. m.

It is now rumored that Bermuda is to have an electric road, and as the scheme will doubtless be carried out, the beautiful Island will be entitled to consider itself as abreast of the times in every electrical art. There is no reason why it should not enjoy all the blessings of electricity in common with the rest of the world, especially in view of its nearness to America.

CANDEE'S IMPROVED CABLE.

It is a well-known fact that underground cables suffer considerably from the entrance of moisture, and even when carefully examined and free from the same at the works are frequently deteriorated by moisture while in the process of laying through careless handling. To avoid this occurrence in cables having paper or fibrous insulation Mr. Willard L. Candee has recently devised a simple method which consists in surrounding the several wires of the cable for a distance of, say, six inches or more from the ends of the sections in a waterproof substance such as okonite, rubber, gutta percha, or the like—filling with such substance the interior of the protective sheath or casing. At the ends of the conductors where the waterproof compound is applied, the fibrous wrapping or envelope is removed, so that the okonite or other material comes into direct contact with the wires and envelops them individually as well as collectively. This is clearly illustrated in the accompanying engraving which shows a number of conductors *a*. Near the end of the cable the several conductors are provided with a coating *c* of waterproof material extending some distance from the ends, and a mass *d* of similar material placed around the entire group of wires, the whole being enclosed by the sheath *e*.

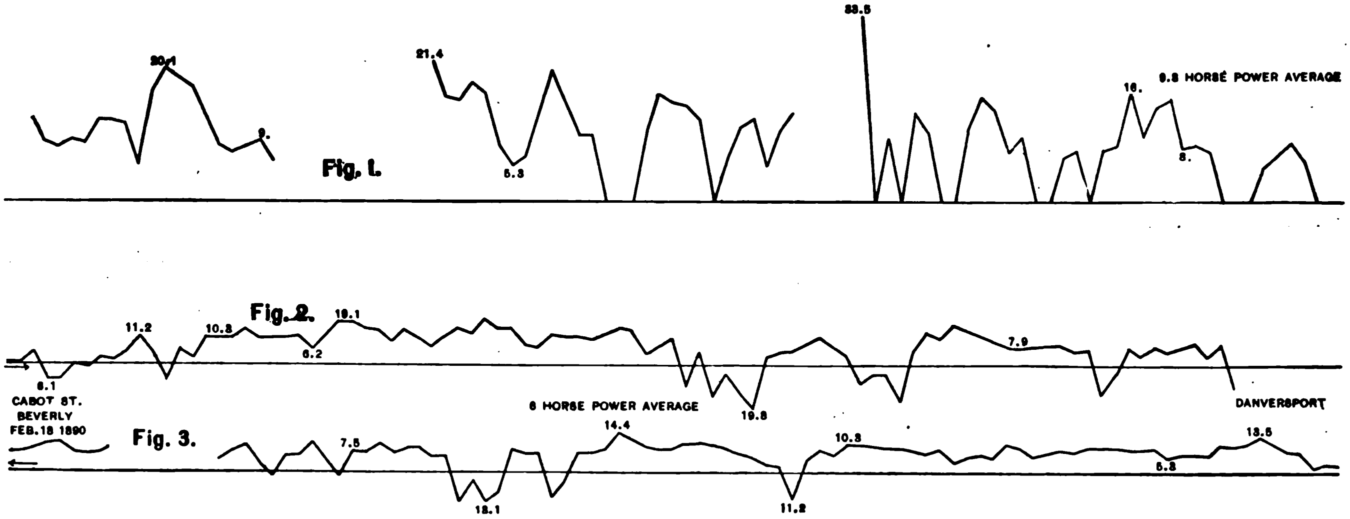


Candee's Improved Cable.

The presence in the cable of a plug or filling of water-repellant substance at intervals effectually prevents access of moisture to such parts of the conductors as are enclosed in the fibrous insulating material, which in conjunction with the exterior case or sheath is claimed to protect the insulation as perfectly as if the conductors were separately incased in a waterproof insulating compound for their entire length.

COMPARATIVE CURVES OF HORSE-POWER CONSUMED ON ELECTRIC RAILWAYS.

We illustrate this week two interesting curves taken on different electric railroads, showing in a graphic method the amount of horse-power necessary to propel electric cars. The upper curve was made from data taken on a car on a level road, using the ordinary overhead single trolley system, with the motor armature geared to the wheels by the ordinary two sets of gears open to the dust gathered from the road. The lower curve was formed from data taken on the Beverly and Danvers Railroad, which is very hilly, on a car fitted with the Union Electric Car Company's system of improved enclosed gearing, and using storage batteries, which, when running down hill, or when stopping the car, charge back into the battery. As will be seen from the first curve, it took about twelve horse-power to start the car at first, the gear being new; and at a certain part of the road consumed 20.1 horse power. The next start took 21.4 horse-power, while the third start took 33.5 horse-power, presumably owing to the gear getting dirty, making an average throughout of 9.8 horse-power over the whole run. In the lower curve on the Beverly road the car was started with from 5 to 10 horse-power, and running at the same speed as in the former test the highest horse-power consumed was 16.1, while where the curve passes below the horizontal or "no-current" line, considerable saving was effected by charging back, as much as 19.8 in one case being returned to the battery. The average horse-power in this case is put down at 6, but as a matter of fact it is about 5.54. The saving over the whole line by charging back is about 14 per cent. The economy in this test, outside of the charging back, is plainly attributable to the improved gearing, which is enclosed in a dust-tight box and runs all the time in oil. These gears have therefore extremely little friction to overcome, and never get clogged up with dirt. The saving in such a case is not at first easily seen, but we think a careful study of the above curves will prove that there is yet much to be improved in the ordinary method of running electric cars, and they will serve as an explanation of the acknowledged and unnecessarily high power which to-day is regularly being consumed on electric railroads.



Electric Railway Power Curves.

INSPECTING THE HALIFAX-BERMUDA CABLE.

Mr. G. G. Ward, the general manager of the Commercial Cable Company, has favored us with a copy of a despatch as follows, received May 22:

"Yesterday a number of gentlemen interested in submarine telegraphy visited the steamer 'Westmeath' (which sails to-day), lying off Greenhithe, for the purpose of inspecting the cable about to be transmitted abroad by the Halifax and Bermudas Cable Company, Limited. The cable, which is 874 miles in length and weighs 2,061 tons, has been manufactured by the Henley Telegraph Company, Limited. When the 'Westmeath' has discharged her burden and the shore ends have been fixed, telegraphic communication will be established between Halifax and the Bermudas, which may form the basis of subsequent developments. The British Government have granted a subsidy of £8,100 to the company, but the post-office authorities have insisted on certain conditions as to the capacity of the cable, all of which requirements have been fulfilled. It is expected communication will be established by June 24th. The tariff will be 8 shillings per word between Halifax and Bermudas, and 4 shillings from England. An interesting feature in connection with the laying of the cable is that it is the first that will cross the Gulf Stream."

WESTERN ELECTRIC PLANT, VIRGINIA HOTEL, CHICAGO.

THE electrical equipment of the larger apartment houses in such cities as New York and Chicago is now, and none too soon, being brought up to the standard of excellence and convenience attainable. In many instances that have come under our notice, the apartment house plant has been "neither fish, flesh, fowl nor good red herring," but an olla podrida of details hardly any of which were designed for the work or were strictly suitable for it. If the owner had wasted his substance in riotous baloonies and pinnacles of carved stone, it is probable that he stinted in the allowance for the electric lighting; if that were not the case, it happened that the work was entrusted to incapable hands. Hence the examples of cheapness and inefficiency have been many and near together, and it is only within a recent period that such plants have approximated the ideal.

We are glad to be able to illustrate in this issue a plant that seems to us to embody a well devised plan, to comprise proper devices and apparatus, to furnish the essentials of safety and comfort, and to present not a few points of novelty and originality. The plant in question is that installed by the Western Electric Company in the McCormick apartment building, or, as it is called, the Virginia Hotel, on Rush and Ohio streets, Chicago. This building was wired for about 3,000 incandescent lights, and the system of mains and feeders is such that an almost absolutely equal potential is obtained at the different distributing points. The connections are made through heavy brass contact pieces placed in pockets lined with asbestos and easily accessible; so that the wiring in any part of the building may be readily cut out for any purpose desired, without interfering in the least with the other circuits or lamps. The branch cutouts are of new design, each being provided with a double pole disconnecting switch. Their construction obviates entirely the use of a screwdriver in replacing fuses, etc., as the clamps for catching the fuses are operated by thumb screws. These cutouts are placed in pockets throughout the building, all of which are at any time readily accessible.

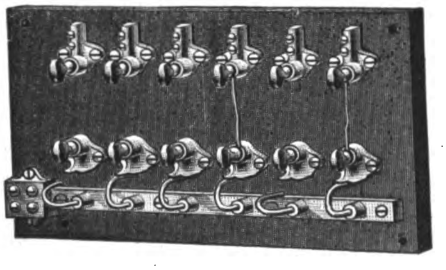


FIG. 5.—WESTERN ELECTRIC MULTIPLE CUTOUT.

In the dynamo room, Fig. 1, the driving power for the Western Electric dynamos, which have been illustrated in this paper in detail, is obtained from two Corliss engines of 150 h. p. and 90 h. p. respectively, which are belted to the countershaft from which the dynamos are driven. The shaft is made in two sections, which may be connected by a positive clutch so that the engines may be run independently or together, as desired. The friction clutch pulleys provided also permit the use of any or all of the dynamos at one time. Rawhide rope gearing is used throughout. The arrangements are extremely simple and flexible.

The four dynamos are of 400 ampere capacity each. The armatures are built up with a single layer of bare copper wire with large commutator segments, and the current is conducted to the switchboard by means of a Patterson underground cable of 425,000 c. m. which contains in its centre, insulated from the main conductors, the wire leading to the dynamo rheostat on the switchboard.

The switchboard, Fig. 2, is of highly polished oak, upon which the various instruments are symmetrically mounted, with an eye to tasteful display of polished brass, copper, etc.

Another feature of the plant is the new multiple cutout board, Fig. 3, in which special attention has been paid to the requirements necessary to insure safety, while at the same time the construction is such as to render it cheap and serviceable. All metal parts are secured to the base by screws passing through the metal into the base; no bolts of any kind being allowed to pass through the base. The bar or strip lying along the lower edge of the board is provided with curved spring switches, Fig. 5, that, when closed, are held firmly in place by a slight indentation or notch upon the lower surface of the contact base. Whenever it is desired to insert a fuse wire or to test a circuit, the spring switches upon both the positive and negative sides can be quickly opened for either purpose. They are manufactured in sizes to suit the varying requirements; the sizes ordinarily used being from four circuits up to fourteen. By reason of its great simplicity and substantial construction this cutout cannot fail to find favor with electrical engineers generally.

The electrical equipment of the Virginia Hotel is not less perfect in the other matters of call bells, tubes, etc. The electric call bell system, in fact, is a decided novelty. Each of the 60 apartments has calls from the private hall to the office, and from the servants' entrance to each kitchen. Every apartment has a call to the office in connection with the tube system. In the office there is a 60-number circular switch, arranged so that each apartment can be called separately, or all at once, as in case of fire. Each of the 60 dining-rooms has calls to the kitchen, with silk cord and spring jack plugs.

In the speaking tube system there are six 2-inch tubes from the tenth story to the office, or one tube for each tier of ten apartments. There are six 2-inch tubes from the tenth story to the janitor's room, or one tube for each tier of ten apartments. There are separate tubes to the main dining-room, kitchens and drug store. In case any one is called for on the city telephone, the clerk in the office can communicate with the party occupying any of the apartments without bothering them to come to the telephone in person.

In each of the two passenger elevators there is a 10-number elevator annunciator, with a push on each floor, connected with a flexible cable to the cab. All the pushes are of Bower-Barff bronze. In the janitor's room there is an annunciator that is operated from each floor by the four freight elevators, so that the janitor can tell at once which floor the call is from.

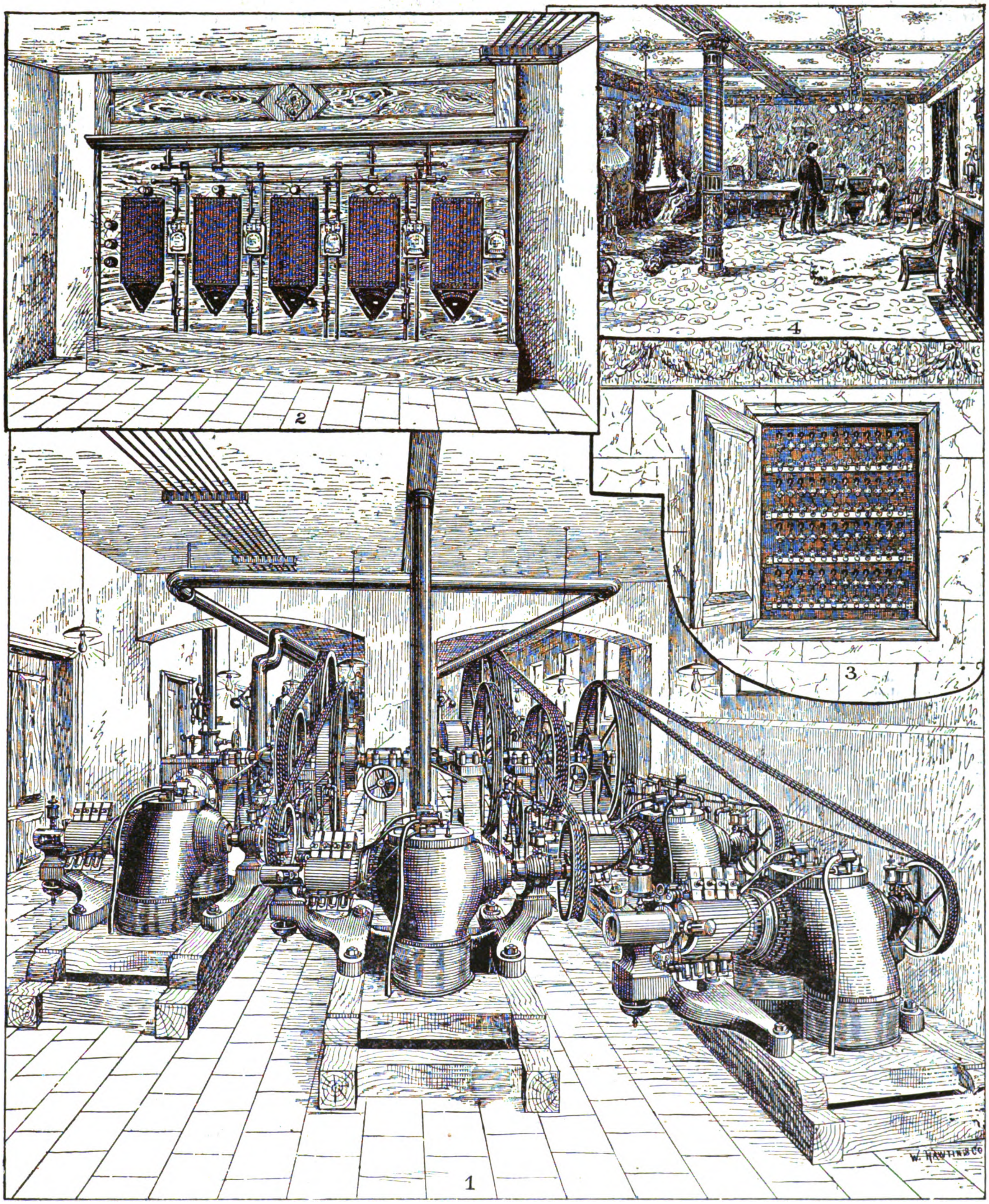
Thus it will be seen electricity has been resorted to for a variety of uses and services; and the results are eminently satisfactory to all dependent upon the plant for their comfort by day or night.

ELECTRIC RAILROADS.

BY R. S. DOBBIE.

ONLY those who are familiar with the struggles that the locomotive endured in its early days can appreciate how gradual was the evolution and slow the growth of the splendid engines of to-day, which seem the very embodiment of perfection. But on looking at the efforts of early locomotive builders we are at once struck by the fearful and wonderful complexity of the motive mechanism. "Sun and planet motions," "grasshopper beams" and a labyrinth of gear-wheels were once in high favor, and it was only the stern law of the survival of the fittest, that has given us the modern locomotive, so elegant in its simplicity, and so perfect in its fulfillment of practical requirements, that we almost think that it will stand unrivaled and unchanged forever.

We will here draw two interesting parallels—first, one between the steam and the electric locomotive. Both of them in the early stage of their existence suffered from gears and cog-wheels; these have disappeared from the steam locomotive and assuredly will do so in the electric locomotive of the future. Second, between two electrical industries, lighting and traction. Development of the former was hindered by the supposition that any shanty was good enough for a dynamo, and in the latter, dirt and mud do not seem to be considered as out of place when in gears and on commutators. Continuing our examination, we find that a few flimsy pieces of painted cotton, upon which the reliability of the entire machine depends may give way to the stresses, mechanical and electrical, that are brought to bear upon them. What would we think of a steam locomotive that virtually de-



Figs. 1, 2, 3 and 4.—Western Electric Plant, Virginia Hotel, Chicago.

pended as to its reliability upon a poor little scrap of cotton? The steam locomotive, however, only slowly attained its present practical development; and so the electric locomotive, despite our advanced knowledge of electrical laws, will only slowly become, as assuredly it will become in the near future, *the* perfect means of locomotion that we hope for and dream about.

Now let us suppose that all the gears, sprockets and chains, and friction wheels now considered so necessary, were swept away and the armature placed directly upon the axle. What would we have to do in order to keep the power the same? In the first place the motor would have to be considerably heavier than the motor of a geared car; but when we consider the weight of the gearing and frames, etc., necessary, it will be found that the discrepancy is not so great as may be imagined. For instance, at a lineal speed of 3,500 feet per minute of the armature, an output of 12 watts per pound weight of motor can be obtained. Now on a street car with wheels about 30 inches in diameter, it is possible to put an armature of 18 inches diameter; this in a 4-pole field will clear the street about 5 inches. Supposing the car to be traveling at 10 miles an hour we would have a lineal armature speed of 520 feet per minute, which is about 1/7 of the speed in armatures of ordinary machines. Now as the speed and weight are both in direct proportion to the power, we must increase the weight (since the speed, by the conditions, is limited) in the above ratio which, more exactly, is as 1 to 6.8. That is, we must make the slow-running armature 6.8 times the weight of one that runs at 6.8 times the lineal speed.

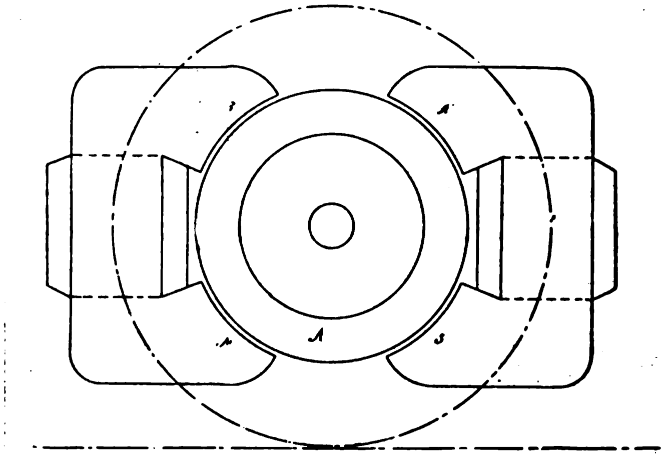


FIG. 2.—DESIGN FOR DIRECT CONNECTED RAILWAY MOTOR.

With say, 10 h. p. on one axle this would require about 4,000 lbs. in the motors; a weight, it is true, above that now usually used; but against this one objection we have many advantages: a reliable and durable motor not easily destroyed by a sudden rush of current, no noise, no gear, and the possibility of speeds far higher than the one taken here.

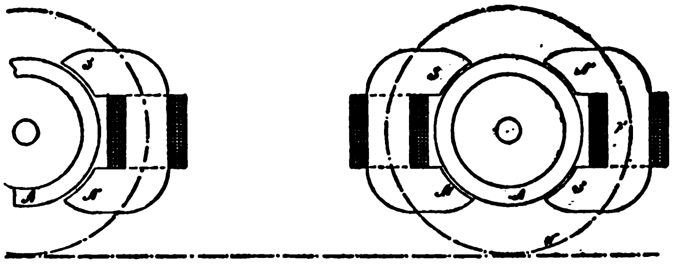


FIG. 1.—DESIGN FOR DIRECT CONNECTED STREET CAR MOTOR.

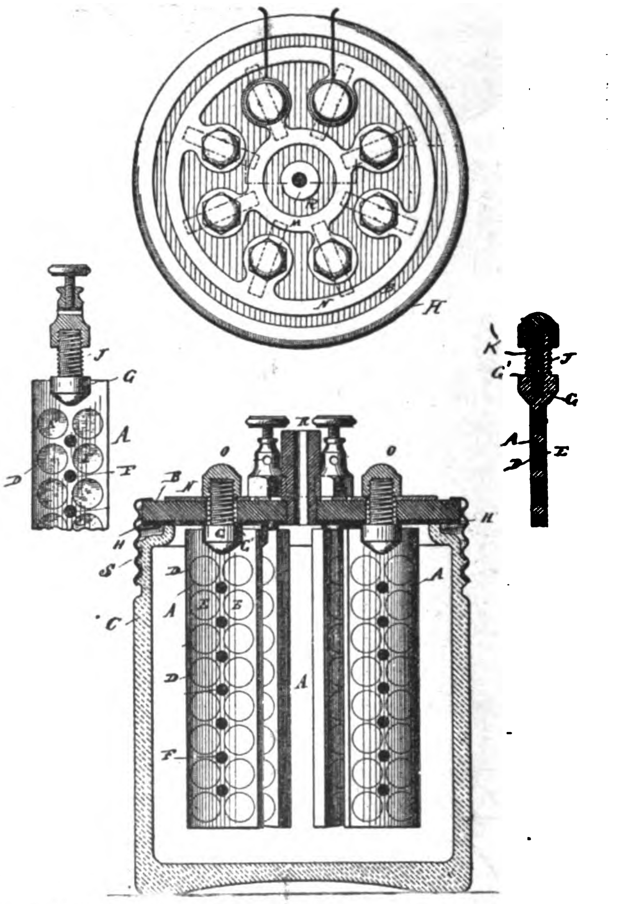
The accompanying illustration, Fig. 1, shows the arrangements for a direct-driving street car with two motors, each of 10 h. p., and designed to run normally at 10 miles an hour. The wheels are 30 inches in diameter, and the axial length of the armature and field magnets is 20 inches. The armature is 18 inches in diameter and revolves in a 4-pole field. Each motor weighs 2 tons, so that their combined weight is 4 tons. While the present design contemplates an axial length of armature and field of only 20 inches, there is sufficient room to increase this to 30 inches if desired.

I have made careful calculation and designs of motors with far more ambitious speed, and find that at speeds of 60 miles an hour with 72 inch wheels and a motor weighing 12 to 14 tons, on one axle a power of 350 to 400 h. p. is possible. A direct-driving high speed electric locomotive on this plan is shown in Fig. 2. The design shows an armature 45 inches in diameter and 30 inches long.

It does not need a prophet to say that no such power or speed is practical with gears, belts or any means of this nature that could be applied.

THE NEVINS SECONDARY BATTERY.

WE illustrate in the accompanying engravings a novel form of storage battery, the invention of Mr. Thomas F. Nevins, of Brooklyn. In this battery the electrodes A are suspended from the insulating cover B, resting on the top of the jar. The electrodes are composed of an alloy of lead and tin, containing not more than thirty parts of tin, and have two vertical rows of apertures D, the edges of which are beveled inward from both faces of the electrode, so as to form pockets for receiving the filling E of the oxide of lead. Additional apertures F are provided between the apertures D to permit of a thorough circulation of the exciting liquid.



FIGS. 1, 2, 3 and 4.—THE NEVINS SECONDARY BATTERY.

Each electrode is provided at its upper end with a projection G, the top of which forms the shoulders G′, which rest against the rubber packing plate H on the under side of the cover. From the projection G′ a threaded stem J projects upward, which contains a threaded core K, of iron, for the purpose of rendering the stem more durable. These stems are passed through apertures in the plate B and through apertures in the lugs of two rings M and N on the upper surface of the cover. The lugs of these rings alternate, as shown, so that the electrodes are alternately held in the lugs of the rings M and N. The ring M is connected with the positive wire and the ring N with the negative. Nuts are screwed on those ends of the stems J projecting above the rings, and by drawing them tight the electrodes are held in place and the rings clamped firmly on the top of the cover. A nut on one lug of the ring M and another nut on one lug of the ring N are provided with a projection through which the conducting wire can be attached.

A vent tube R projects through the top of the cover to permit the escape of gases, and a screw ring S is screwed on the jar, and its flange, pressing on the cover, presses the rubber packing plate H on the top edge of the jar, thus forming a tight joint. The electrodes are arranged radially, as shown in Fig. 1.

The arrangement is such that any electrode that has become destroyed, can be easily removed and another substituted.

NEW PORTABLE TESTING AND RESISTANCE SETS.

We illustrate on this page the new series of portable testing and resistance sets which are being put on the market by Messrs. Queen & Co., the well-known electrical instrument manufacturers of Philadelphia. These sets were all designed in their laboratory, and are intended to meet the requirements of electric light men, telephone line construction, dynamo and motor manufacture and general testing. They will be found adapted to the location of faults in telegraph and electric light lines, determination of armature and field resistance of dynamos and motors and the needs of government and other inspectors as well as to general expert work.

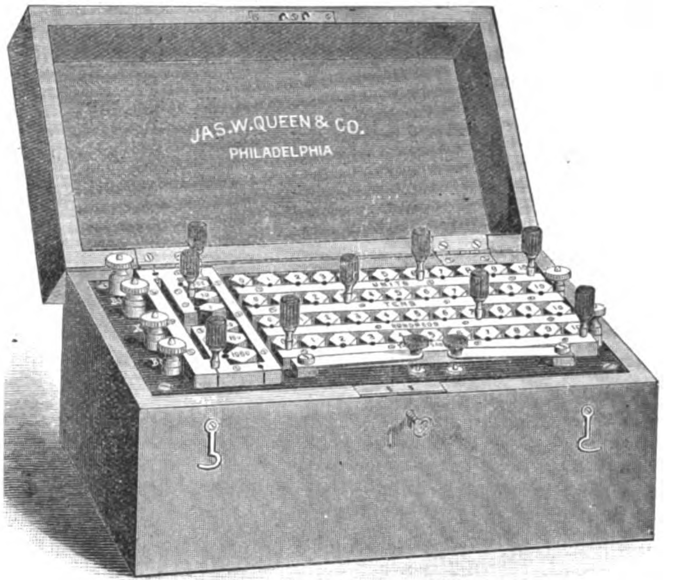
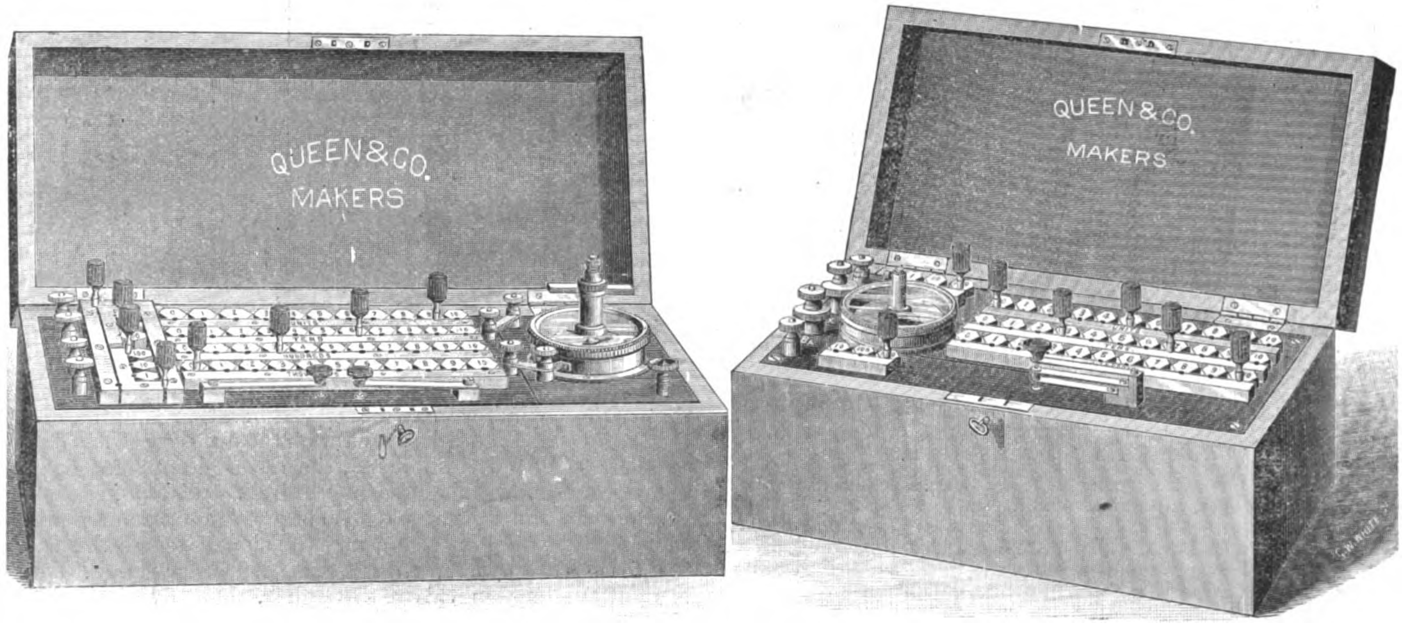


Fig. 2.—New Portable Testing and Resistance Sets.


QUEEN & CO.
MAKERS
QUEEN & CO.
MAKERS

Figs. 1 and 3.—New Portable Testing and Resistance Sets.

The set shown in Fig. 1 is the best and most complete of the series, and is recommended for all kinds of work where considerable accuracy is required. The coils in this set are, as shown in the figure, arranged in four rows, each row being made up of ten coils of the same denomination. The blocks in each row are numbered from left to right and from zero to ten, while the longitudinal bars underneath have engraved upon them the denomination of the coils of that row. The connections of the coils are such that but one plug is required for each denomination; by inserting it in any block as many coils of that denomination are thrown in as may be indicated by the particular number engraved upon the block; thus, as the cut represents it, there are in circuit 369 ohms, *i. e.*, no thousands, three hundreds, six tens and nine units. Another special feature of this set is the arrangement of the bridge arms which are seen at the left; these are combined with reversing bars so that the proportional arms may be instantly interchanged, an operation which is absolutely necessary in many special methods. An additional advantage is that but six coils are necessary in the bridge instead of eight as usual, to get the proportion of 1 to 1,000 or 1,000 to 1, thus making the set smaller and more portable. The bridge coils are 1, 10 and 100 on one side and 10, 100 and 1,000 on the other. To effect this reversal, two plugs only have to be changed. The use of this reversing arrangement in testing sets is original with Messrs. Queen & Co., it having never before been employed, we believe, except in the most expensive and elaborate laboratory instruments. The coils are wound of the now famous platinoid wire, which has a very high specific resistance and changing by but .0023 per cent. for each degree Centigrade of temperature variation. They are adjusted by Prof. Wm. A. Anthony to an accuracy of from one-fifth to one-tenth of one per cent. while the bridge arms themselves are adjusted to a still higher degree of accuracy. The galvanometer is a successful adaptation of a laboratory instrument to the needs of portable work and is by far the most sensitive, complete and portable instrument ever combined with a set of this character. The wire is of several hundred ohms resistance and is wound so as to have a maximum effect upon the needle; the needle itself is an astatic one and delicately suspended by a very fine cocoon fibre so that there is practically no resistance to any deflecting force. By means of a very weak controlling magnet sliding upon the suspension tube, the needle can be made almost perfectly astatic and will show an appreciable deflection for currents as small as from one three-thousandth to one five-thousandth of a milliampere; the brass box containing needle and coil is movable about a vertical axis so that the needle can always be brought to zero whatever the position of the box as a whole. The whole galvanometer lifts out of its position in the case and can be used independently or in connection with other apparatus if desired, three leveling screws being provided for leveling when so used. By closing the cover of the box the weight of the needle is automatically taken from the fibre and the latter protected from injury. The battery and galvanometer key are seen in the front of the box and are independent of each other. The whole is mounted up in a polished mahogany box with leather handles and lock and key and measures when complete but 18 in. long by 6½ in. broad. Fig. 2 is a cut of the bridge set without the galvanometer and it is, of course, somewhat shorter. These sets have a range of measurement of from $\frac{1}{1000}$ ohms to 10 megohms.

Fig. 3 shows one of the other sets of the series and is of much the same general character. The coils instead of platinoid are made of German silver and are not quite so accurately adjusted, while the set is without the reversing arrangement found in the one just described. The galvanometer also is fibre suspended, but without the automatic release; for this purpose a small set screw is used which allows the needle to be lowered when not in use; the galvanometer is permanently mounted in the case and is without the control magnet. The keys are combined into the regular double contact form. This set as represented in the cut has but three rows of resistance, viz.: the units, tens and hundreds; it is also made with an additional row of thousands. This set is also made without the galvanometer.

A great number of the sets above described have been sold in all parts of the country and have given great satisfaction. They have been worked upon for some time and improved until they have reached their present satisfactory form. They are now being manufactured in large quantities by Messrs. Queen & Co. and introduced widely throughout the country.

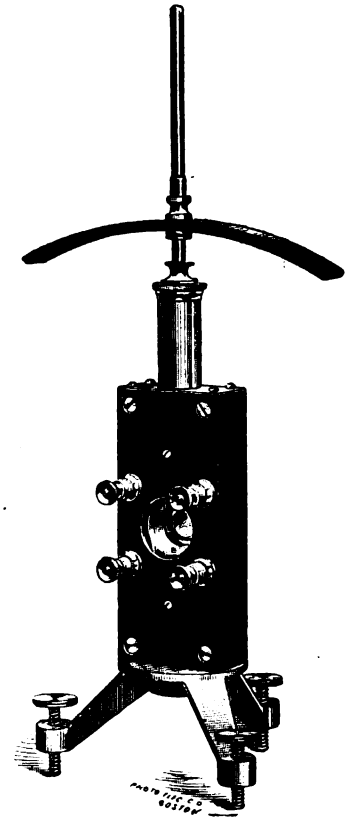
THE SCHARF GAS BATTERY.

The Scharf gas battery consists of a gas-tight vessel, preferably of cylindrical form, capable of holding the gases under very considerable pressure. The idea is to work with two gases in pairs, or with one gas and a liquid—one gas or liquid forming the positive, and the other the negative element in the cell. Among the gases of one class named by Mr. Scharf as suitable for his purpose are hydrogen, water gas, generator gas, coal gas, and all the vapors of the more or less volatile hydrocarbons of mineral oil. In the other class are placed air, oxygen, chlorine, fluorine, and the liquids hydrogen peroxide and nitric acid. Two typical gases for use in this way would be coal gas and oxygen, which would be compressed and stored separately. Each gas is admitted to one side of a carbon diaphragm, or rather, between two adjacent carbon diaphragms, contained in the vessel already described, and the plates of carbon are separated into pairs by alternate spaces filled with a gas and with asbestos saturated with acidulated water. All the intervals of even numbers in the pile would thus contain one gas, and all the others another of opposite electrical condition. In this way a pile of any number of cells might be built up.

A NEW FORM OF REFLECTING GALVANOMETER.

One of the essentials of a good reflecting galvanometer is that the exciting coils should be well insulated and as near to the needle as possible, in order to have the greatest effect upon it. Again, the coils should be well protected from injury and at the same time it should be easy to get at the needle in order to replace a broken fiber. The needle should be light and all parts should be reduced to the simplest form, while the whole should be firm upon its base in order to resist vibration. To meet these requirements, Messrs. E. S. Ritchie & Sons, of Brookline, Mass., have devised the instrument shown in the accompanying engraving.

It consists of a vulcanite case made, practically, in two parts. The exciting coils are held firmly in each part, so that when the pieces are screwed together the inner faces of the coils approach within one tenth of an inch to one another. When the instrument is made with four coils, the distance between the upper and lower pair of coils is sufficient to allow an opening to be made through the case, in order that a glass window may be placed in either side to allow the light to reach the glass mirror on the needle. When only one pair of coils are employed, the opening is placed either above or below the coils as desired. There is a slit through the top of the vulcanite case, which reaches below the centre of the lower coil, and the space around the coils is filled with paraffine so that when the case is closed, there is a slit running lengthwise through it, about five-eighths or three-quarters of an inch laterally, and as wide as the distance between the coils.



New Reflecting Galvanometer.

The coils are made of any desired resistance; each coil may be connected with a pair of pole cups on its own side of the instrument, or the opposite pairs of coils may be connected to one pair of pole cups upon the front of the instrument. In the former case they may be connected either in series or in multiple arc; in the latter case in series only. The coils once in place there should be no need to remove them, and the danger of injury is reduced to a minimum. But should it be desirable to examine the coils for any purpose, the case can be easily unscrewed, one part from the other, and the coils exposed to view.

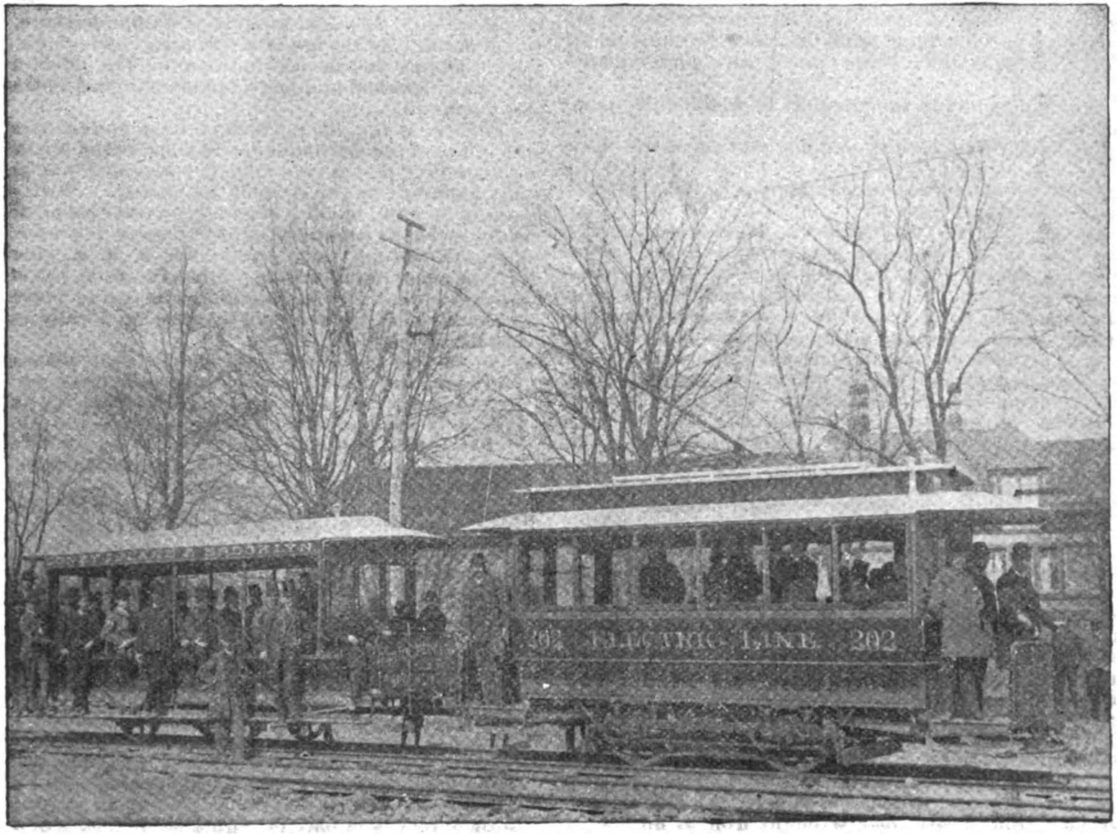
The fibre suspension is outside the vulcanite case. A small pin with a block passes through a marble cap at the top of a sliding tube, which can be raised, or lowered, or turned upon a vertical axis to remove the tension of the fiber. When it is desired to introduce the needle into place it is simply slipped into the slit in the top of the case till the mirror is in the centre of the opening in the side of the case. The fibre is easily fastened to the needle, as the work is done outside the case in the most convenient manner. When it is desired to remove the needle, the case is simply inverted, and it slides out without trouble, the tube carrying the supporting pin being removed at the same time. Two needles are made for the instrument, one of which is dead beat, and the other for use when the throw of the needle is used, as in insulation testing. The fibre suspension is covered by the adjusting magnet support. The whole case is fixed to a brass tripod with leveling screws, by thumb-screws, so that when it is desirable to use it as a portable instrument, the rod carrying the magnet is removed from the case and that in turn from the brass tripod, so that it can be packed into a very small space. As the exciting coils are entirely protected from injury in handling, this instrument is especially adapted for the use of students, or where a portable instrument is needed by the electrical engineer. The instrument as ordinarily made will give a deflection of one millimetre with the scale at one metre distance, with an E. M. F. of one volt through a resistance of 1,100 megohms.

Robbing Western Union.—It is reported from South Dakota that large defalcations have been discovered there by the Western Union Telegraph Company, reaching, in fact, a sum of from $50,000 to $75,000. Another discovery is that certain officials have been working in the interests of the lottery scheme, and that Northern Pacific officials have been assisting in the little game. In other words, telegrams favorable to the lottery project have been expedited, those unfavorable have been held back; and the secrets of their opponents have been revealed to the lottery ring.

ELECTRIC ROAD AT CONEY ISLAND N. Y.

The equipment of the Brooklyn and Coney Island Railroad has just been completed by the Thomson-Houston Electric Company, on its well-known system. This road consists of sixteen miles of track which is equipped with central pole double bracket suspension, the trolley wire being suspended from poles placed between the tracks 125 feet apart, and provided with ornamental iron brackets. The construction is done in the most thorough and workmanlike manner, and the general artistic appearance of the line has caused much favorable comment.

The car equipment consists of twelve double motor cars, and others will soon be added. The power station is provided with the necessary boilers for supplying steam to three 200 h. p. engines, and the usual heaters, pumps, etc. The electrical apparatus consists of six 100 h. p. Thomson-Houston railway generators, of the four pole type, and switchboard with the usual fittings. A part of the station is used as a car house and is provided with eight tracks with pits underneath, thus rendering the cleaning and repair work an easy matter.



Brooklyn and Coney Island Electric Railway.

A TELEGRAPH LINE IN AFRICA.

It would undoubtedly be possible, says the New York *Sun* to deliver in a few hours a cablegram sent from New York to Europe, down the African coast to Senegambia, up the Senegal River to Kayes, and through the forests to Seguiri on the Upper Niger, hundreds of miles from the coast, and for a long distance through a savage region in which there is not a single white station. In that region one sees no telegraph poles save those that nature planted, for the wire is fastened high up in the trees of the interminable forest. All the branches and foliage that would be likely to break the wire or interfere with its efficiency are carefully trimmed away. Probably the longest stretch of telegraph wire in the world through a wholly uninhabited region is that extending clear through Australia from south to north. It crosses the great interior wilderness which explorers so long tried in vain to traverse, though they were stimulated to their best exertions by the splendid offer of $50,000 which the Australian Governments pledged themselves to pay to the first man who crossed the continent from south to north.

AUTOMATIC ELECTRIC WELDING MACHINES.[1]

BY HERMANN LEMP, JR.

AMONG the latest achievements in electrotechnics, stands prominently Prof. Thomson's electric welding process. The broad underlying principle has so often been described and exhibited by its able discoverer and others, that to repeat it now would be imposing upon your patience. The evolution of a new process and its reduction to practice for commercial purposes, especially if the leading elements of its working are novel in themselves, must necessarily open a vast field for investigation. Such is the case with electric welding, and with a view of showing the commercial apparatus of to-day, it will be necessary for me to state the electrical and mechanical requirements which led to its construction.

The reason for which machines have been invented has been for the purpose of reproducing faithfully and constantly a set of conditions necessary to obtain a certain result. When the conditions in any case are few and the product simple, generally one design of machine will be sufficient. With an increased number of conditions, however, the complexity of the apparatus increases rapidly and demands, in many cases, a subdivision into different processes to be executed by separate machinery. What constitutes skill in a workman, for instance, is the ability to co-ordinately reproduce a number of operations or movements; to be, in other words, a perfect machine, or to produce the same result even if other conditions than those previously contemplated should arise.

To secure uniform results in the practice of a difficult operation, there are two ways possible.

1. To employ skilled help for the complex portion of the work alone.
2. To substitute for the more complex portion of the operation one more readily controlled.

The ordinary welding process requires the greatest skill at the hands of the blacksmith for heating the metals to the proper temperature and at the right spot, while preventing the accumulation of cinder or scale. While skill may be successful with metals of high melting points and low conductivity for heat, easily fusible metals and especially good conductors baffle all attempts as long as an exterior heating source is employed.

The electric welding process has, as you know, not only made it possible that operators not particularly skilled in the art of blacksmithing can produce good substantial welds, but has created an art equally adaptable to all metals and combinations of metals.

The following are all the metals, alloys and combinations so far actually welded with success by the Thomson process:

Metals.—Wrought iron, cast copper, antimony, aluminum, manganese, cast iron, lead, cobalt, silver, magnesium, malleable iron, tin, nickel, platinum, wrought copper, zinc, bismuth, gold (pure).

Alloys.—Various grades of tool steel, various grades of mild steel, steel castings, chrome steel, Musshet steel, stub steel, crescent steel, bessemer steel, cast brass, gun metal, brass composition, fuse metal, type metal, solder metal, german silver, aluminum alloyed with iron, aluminum brass, aluminum bronze, phosphor bronze, silicon bronze, coin silver, various grades of gold.

Combinations.—Copper to brass, copper to wrought iron, copper to german silver, copper to gold, copper to silver, brass to wrought iron, brass to cast iron, tin to zinc, tin to brass, brass to german silver, brass to tin, brass to mild steel, wrought iron to cast iron, wrought iron to cast steel, wrought iron to mild steel, wrought iron to tool steel, gold to german silver, gold to silver, gold to platinum, silver to platinum, wrought iron to Musshet steel, wrought iron to stub steel, wrought iron to crescent steel, wrought iron to cast brass, wrought iron to german silver, wrought iron to nickel, tin to lead.

But Prof. Thomson was not satisfied with this progress made above ordinary welding, and early recognized the importance of a machine in which all conditions for successful operations are mechanically controlled to produce uniform results, and which would be rapid working and require little or no attendance.

Such machines, now known as automatic welding machines, have proved to be of special importance in connection with easily fusible metals, enabling the successful welding of aluminum, silicon and aluminum bronze, which, even with the electric process, require considerable skill.

Before entering into a detailed description of the automatic welder a few general data on welding will be in order.

The Thomson process of electric welding can be, and has been, worked by means of continuous or alternating currents; secondary batteries or multipolar machines may be and have been used. There are such conditions as transportability, absence of motive power, situation in continuous distribution district, etc., which may make it advisable to use the continuous current. The alternating currents have so far been the best adapted to produce economically of large volume at low E. M. F. They are easily and economically controlled, allow of being distributed at high pressure with small conductors and of being reduced to working pressure wherever needed. They have, however, another beneficial effect, which is of importance in all welds of large sections.

It is a well-known fact amongst manufacturers of incandescent lamp filaments of large section that the inner portion in a filament is apt to be overheated. In treating filaments as used in the now commercial series lamp, in a hydro-carbon atmosphere, the writer attempted at one time to produce an extra good quality of carbon by starting with an extremely thin base .004 inch thick and obtaining a filament, 90 to 95 per cent. of which consisted of hard, gray, lustrous carbon. He thought to extend this process to the manufacture of arc light carbons and even produced pencils of about ¼ inch diameter. What was his surprise, however, to find that although the lustrous surface presented at all times a dense gray structure, the core lost this character after a certain thickness of carbon had been deposited. In fact, a number of concentric layers could be discovered from the innermost graphite to the dense gray semi-crystalline at the outside.

This action can, to my mind, only be attributed to the overheating of the carbon particles in the inside. A similar action takes place in a bar of iron if heated by an electric current. The surface exposed to radiation will be at a lower temperature than the core. It is true that the heating of the metal will increase its resistance and thus tend to equalize the temperature, but not enough in all cases. By the use of alternating currents we gain, however, an assistance in the self-induction. The effect of the latter is especially marked and has a tendency to concentrate the heat on the surface.

If there is any place which receives more current than another the effect of the self-induction is emphasized by the fact that the surrounding part is cool and its permeability is greater than the part traversed by the surplus of current. With very large, and especially wide, metal pieces the unevenness of distribution may be remedied by approaching iron masses to create at a given spot a greater self-induction or counter E. M. F., thus diverting the current from that section. Prof. Thomson has early recognized the importance of, and patented, a device to prevent the heating of the metal at a given spot by creating locally increased self-induction or magnetic effects.

In view of this experiment almost daily witnessed by us, it is interesting to note the paper controversy between parties disputing the priority of a device which is to produce exactly the opposite result with, however, the same means and conditions.

Two methods of distribution are in use, the direct and the indirect. In the former, an alternating current dynamo is used, having two windings on the armature, one of which furnishes currents rendered continuous by a commutator to excite the field magnets, and is controlled by switch and rheostat; the other consisting of a single turn of heavy copper cable furbishes the welding currents, which is led through collector and brushes to movable copper clamps suitable to receive and guide the welding specimens during the operation.

In some other forms the field magnet is the movable part, in which case no heavy currents have to be carried through collector and brushes. No direct welders are built at present for currents larger than 4,000 amperes.

The indirect method of distribution is almost exclusively used to-day. It consists in its simplest form of one alternating current dynamo, self or separately excited, and one welder which is a transformer with the necessary clamping and operating appliances. The self-exciting dynamos used are from 1,000 to 20,000 watts output, and may be regulated by means of a reactive coil to give a varying E. M. F. never exceeding 300 volts.

They are substantially built to withstand sudden strains, have self-oiling bearings; the brushes are designed never to be moved and are perfectly sparkless, requiring no other attendance but cleanliness.

The winding on the transformer being set once for all, variation in the E. M. F. has to be obtained either by varying by hand the initial E. M. F. of the dynamo or by exciting a dynamo to the lowest potential required, it being so compounded as to give with the maximum work the increased E. M. F.; or finally to maintain a constant E. M. F. at the dynamo under all loads and vary the E. M. F. at the transformer by interposing a variable resistance, or preferably a self-inductive resistance. The transformer itself may be built so as to give a different ratio of conversion, either by moving the primary and secondary relatively to each other or by shunting lines of force by means of an iron bridge between primary and secondary, or by altering the number of turns in primary or secondary by a switch.

When a single plant is used, viz., one dynamo and one welder, it is the dynamo, generally, which, if separately excited, is regulated by means of a rheostat in the exciter circuit, or by a reactive coil in series with the exciting coil on the armature if self-excited. The diagram, Fig. 1, shows the connections used with a separately excited machine. The only thing different from similar installations is the break switch which is operated by a foot treadle and automatically opens the circuit when the foot pressure is removed.

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[1] A paper read before the General Meeting of the American Institute of Electrical Engineers, Boston, May 21st, 1890.

This prevents any mishaps when operated by uninitiated persons, as all action ceases when one leaves the apparatus. The primary voltage never exceeds 300 volts with 100 alternations, or 50 complete cycles per second. Nothing but the very best insulation is used in the primary wiring. It is deemed necessary to protect users of the apparatus not only against any shocks, but even against the scare of one, and we recommend the permanent grounding of the secondary which in welding apparatus is virtually the table and pressure devices.

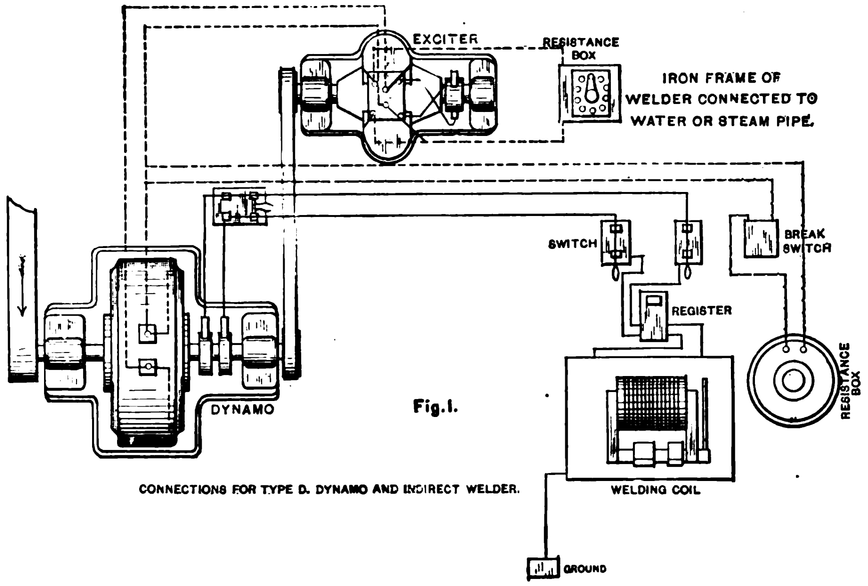


Fig. I.

CONNECTIONS FOR TYPE D. DYNAMO AND INDIRECT WELDER.

Fig. 3

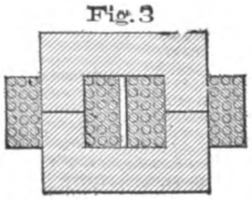
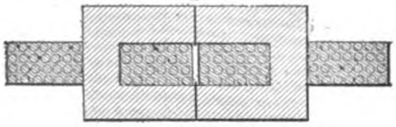


Fig. 4

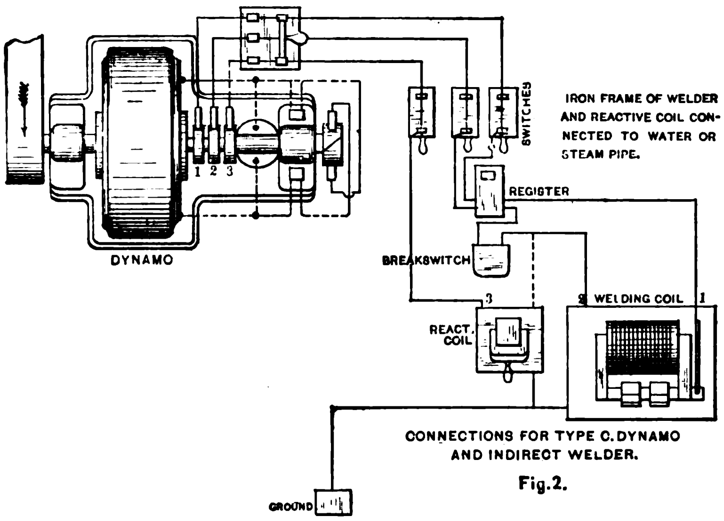


Automatic Electric Welding.

Fig. 2 shows the connections used for a self-excited composite dynamo, which has two windings on the armature, a longer main and shorter exciting coil. Both are wound in the same direction, and currents generated therein pass in multiple, connected through the shunted field magnet; after this through line No. 2, controlled by a break switch, and then split, one returning through reactive coil and line 3, the other through welder and line 1 to their respective windings. The exciting effects of each circuit add themselves. The reactive coil is conveniently placed near the welder. Dynamo is regulated from the minimum to 300 volts and is excited anew for each weld.

For some work which requires to be done at great speed, the second method is resorted to; that is, to keep the field constantly excited by fixing a variable reactive coil in a given position, just enough to produce about 150 volts, the lowest E. M. F. required. The proportion of the field magnets, the E. M. F. of exciting coil and the resistance of a shunt to the field are such as to produce an overcompounding of 100 per cent. in this case, with the largest current in the primary.

This method of regulation is very neat, as it is absolutely automatic, responds quickly, the field of the dynamo not requiring to "build" every time from residual magnetism alone. We sometimes call it "cubic compounding," as it produces a constant heating effect for variable cross sections and variable lengths as well. With this modification, the wiring of diagram, Fig. 4, is slightly altered, the break switch breaking only the main circuit, leaving the exciting circuit permanently closed.


IRON FRAME OF WELDER AND REACTIVE COIL CONNECTED TO WATER OR STEAM PIPE.
SWITCHES
REGISTER
DYNAMO
1 2 3
BREAKSWITCH
3
2
WELDING COIL
1
REACT. COIL
GROUND

CONNECTIONS FOR TYPE C. DYNAMO AND INDIRECT WELDER.

Fig. 2.

Fig. 5

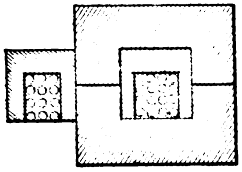


Fig. 7

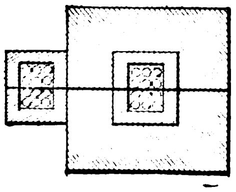


Fig. 6

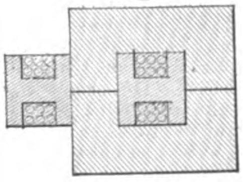
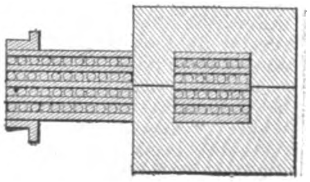


Fig. 8



Automatic Electric Welding.

The methods so far described are only used when a single welding machine is to be operated. It was early recognized that if the process is at all to be used on a commercial basis, the generating of the necessary current at least should be limited to as few machines as possible. It required, in other words, a dynamo giving a nearly constant E. M. F. of sufficient capacity to feed a number of welders while maintaining for each absolute independence.

Since all welding for a long while to come will probably be operated in isolated plants, the dynamo is to be placed in the hands of an engineer, generally not an expert in electrical matters, and has, therefore, to be easily attended and free from all the little faults and kinks which are at present the sole consolation of the dynamo tender. One of its prime requirements is close automatic regulation under all loads.

Constant potential, self-regulating dynamos are manufactured in various sizes and are self-exciting up to 30,000 watts output. Dynamos with larger output are separately excited, but also self-regulating. The methods employed to obtain regulations are novel and will form the subject of another paper at some future date. I would simply state that either constant potential, or a percental increase with load can be obtained and that the regulation will respond even if the load consists of self-inductive translating devices. I lay some stress on the regulation of the dynamo for the reason that the generators are not to be placed in the hands of special attendants as in case of a central station, but have to deliver their currents under constant pressure whatever may be the conditions of work they are subjected to; even an automatic regulator would hardly be able to follow the rapid variation of load.

The following conditions influence the perfection of the work and are variable with different materials and sizes:

1. Projection of the abutted pieces in the path of the current.

2. E. M. F. of welding current as controlling the strength of current flowing.

3. End pressure applied to force the abutting ends into each other at welding heat.

4. Interruption of current at proper time.

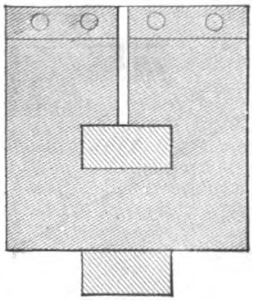
1. The projection of the abutted pieces varies with the diameter. It has been found that for copper, a projection of twice the diameter for each clamp gives the most economical results. With steel and iron, the most economical projection equals the diameter and is one and one-half times the latter for brass.

The projections sensibly affect the energy required and the most economical one depends upon the heat conducting properties and specific resistance of the specimens. Accordingly, highly conducting bodies require longer projections; highly resistant ones, short projections. Conductors of larger and smaller diameters may be welded by giving to each its respective projection. In the same manner wires of different materials may be joined to each other.

It is easily understood that since unequal projections on different sized conductors produce the proper heating of both at their junction, equal projection of equal sized conductors will be required. All other conditions aside, it is important to keep the projection for a given size and material constant.

2. The E. M. F. required depends upon the projection and the resistance of the material to be welded. For large cross sections the specific self-induction plays an important role, and indirectly, the shape of the specimen.

Fig. 9



AUTOMATIC ELECTRIC WELDING.

Another factor affecting the E. M. F. is the resistance between clamps and material and the resistance of copper conductors. The E. M. F. required for iron and steel is nearly double that for copper and would be four times if equal projection were used for both.

A certain drop of E. M. F. will be found from the clamps to the specimens. This drop is rather low on material having naturally bright surfaces, as, for instance, copper, brass, german silver, tin or even cold rolled iron and steel. For a large class of work, however, especially in carriage hardware, the surfaces to be used for contact have a light scale left after passing through the rolls, which has either to be removed by grinding or filing, or to be overcome by the E. M. F. of the current. In a good many cases the introduction of a special process of cleaning is deemed to be more expensive than to use a little extra power to work through the scale.

3. For uniformity of result the end pressure required to press the abutting specimens into each other at welding heat is of more importance than any of the former agencies; this is, in fact, the one which controls and rectifies any inaccuracies in the former conditions. If the pressure necessary for a given size and material is used, the weld cannot be performed until the metal has acquired the necessary plasticity to yield to the pressure. If for one reason or another, the E. M. F. and, consequently, the current should have been too strong, the time necessary for welding alone is affected, and in this case shortened. The bars will, however, be united at the same temperature and with the same force, whatever may have been the time required to bring about the necessary plasticity. The pressure will in some respects influence the heat by forcing the metals into each other at either higher or lower temperature, and by so doing cause the action to be interrupted at an earlier or later period as may be required.

The pressure required varies with the material and is approximately 1,800 lbs. per square inch for steel; 1,200 lbs. per square inch for iron; 600 lbs. per square inch for copper; it varies also with the area of cross section as indicated by its being expressed in a function with the surface as one of the factors.

4. The interruption of the current as soon as the weld is completed is important for all easily fusible metals. When two copper wires are welded together the welded portion being increased in cross section owing to the end pressure, if the current is not interrupted a large portion of the conductor on either side of the weld, including the latter, become heated and will melt and be torn asunder before any pressure device could follow and bridge the gap over.

The current should, therefore, be interrupted as soon as the weld is completed. It is also sometimes required that the parts to be welded should be of a certain predetermined length, in which case the interruption of the current as soon as the allowable distance has been reached is essential.

All these conditions are maintained constant in the automatic welder before us, which is the first commercial type of its kind. This welder is not entirely automatic in the strict sense of the word. The degree of automatic action has to be considered separately for each individual object. This machine contains, however, the leading features as covered by Professor Thomson's patent, June 26, 1888, No. 385,022, with a few improvements in mechanical construction.

The capacity of the machine is, nominally, copper wire, No. 6 to No. 17 A. G. It will, however, weld larger and smaller sizes. It weighs 130 pounds complete; the secondary is one solid copper casting of a cross section resembling a hollow, square box with one of the sides removed. This casting is firmly screwed to an iron table. A saw cut at right angles to the plane of loop creates the two poles, one insulated from the table, the other constituting a V-shaped bearing suitable to receive a sliding clamping device. The hollow part of the secondary receives the primary coil which is separately wound in a form and insulated with special care. Two U-shaped laminated iron cores embrace the primary and secondary.

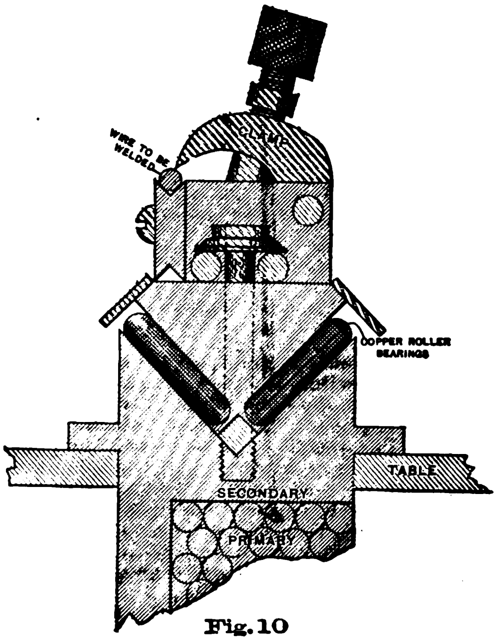


Fig. 10

AUTOMATIC ELECTRIC WELDING.

It has been found that the best form of transformer is the one in which the primary and secondary coils are co-axially placed in an iron core, so as to oblige all lines of force generated by the former to cut through the latter. If the two windings are placed side by side on an iron core or on opposite legs, as shown in Fig. 3, there is a tendency to form consequent poles at the point where the two windings meet, due to the leakage of lines of force. The leakage will depend upon the distance between the two legs, and upon the length of the magnetic circuit. It has been purposely increased and turned to advantage by Prof. Thomson, for obtaining constant current in the secondary while the primary is supplied with constant E. M. F., as shown in Fig. 4. When, however, constant E. M. F. in the secondary is required, it is important that this leakage should be decreased to a minimum.

Various forms of secondary may be employed to work consistent with the above principle. A few of these are shown in diagrams Nos. 5, 6, 7 and 8, in which cases the secondary is preferably a solid copper casting. The forms shown in Figs. 8 and 9, however, permit hard rolled copper plates to be used. For mechanical reasons and convenience, the forms shown in Figs. 5 and 6 are mostly used and actual experience shows practically no leakage. This construction permits of removing the primary without disturbing the secondary in the least. It also gives the least possible self-induction for a given cross section.

It is often stated that when large quantities of alternating currents have to be conveyed through copper conductors, it is important to have the same laminated or subdivided in smaller conductors to reduce self-induction. This may be true to a certain extent. The shape of the cross section is, however, far more important than the lamination. An experimental compound conductor consisting of a number of flat copper ribbons in parallel showed a self-induction of *three* when the ribbons were closely packed, of *two* when separated into two parts, and *one* when spread open like a fan. The explanation for this was given to the Institute last year by Prof. Thomson when he showed the self-induction to depend mostly upon the length of the lines of force surrounding a conductor when traversed by intermittent or alternating currents.

Returning to the subject before us we find that the pole which is insulated from the table constitutes the stationary clamp. The uninsulated pole, which is considerably larger, has on its upper side a long V-shaped groove parallel with the axis of the secondary, Fig. 10. A movable copper block, also V-shaped, fits in the bearing and can be slid forwards and backwards in the same.

This movable block carries the second clamp. The current necessary for welding has to pass through this sliding contact. The welding of small copper wire or any other easily fusible metal, is a very difficult thing if special apparatus is not used. The current required is very large, several hundred amperes for wire not larger than No. 17 A. G.

The metal when it reaches welding heat readily melts away and has to be followed by the movable clamp so as to prevent the breaking of the circuit. This latter action, when it occurs, is so violent that a special device is necessary to prevent injury to the coil in case of such a rupture. The moving clamp, in order to follow the softening of the metal has therefore to have as little friction as possible and yet has to make a good contact to carry the heavy currents. The clamp is furthermore required to move in true guides so as to abut the small conductors with their axes in line. The heating necessarily brought about when rapid and continuous welding is done must not interfere with the bearing and cause the carriage to stick through expansion.

All these conditions have been complied with in using the V bearings, the carriage being held down in contact by means of a heavy spring and a number of copper rollers being interposed between the carriage and the bearing. Fig. 10. The copper rollers are simple short pieces of ¼ inch hard rolled copper wire rounded at the ends. There are sixteen altogether, eight towards the front and eight towards the back of carriage, equally distributed on both sides of the bearing.

A stationary rod at the apex of the bearing prevents the interference of the two rows of rollers. Between the two sets of rollers in front and in back, a bolt passes, applying the spring pressure which forces the carriage into contact with the bearing. A pressure of 40 pounds may be employed, and yet the carriage will move freely. These sixteen rollers have to transmit a current of approximately 3,000 amperes. They absorb about 20 per cent. of the total energy, which loss is, however, fully balanced by the reliability and simplicity of the device. This loss is moreover only on the maximum sizes and becomes insignificant on small work.

An adjustable coiled spring pulls the sliding clamp towards the stationary one. In front and pivoted on a lever is the distance gauge which may be inserted between the two clamps. This gauge carries on a central disk a number of steel pins of varying lengths, but equal projection on either side of the disk. These projections, if inserted between the two clamps, give the necessary distance required for a given size wire, the disk against which the wires are abutted insuring equal projection of both ends to be joined. On the back of the apparatus a switch is located in the primary circuit, which is normally held open by a spring. By moving the handle to the right, the primary will be closed and the switch locked by a little catch underneath the table. A pin fastened to the movable clamp will lift the catch and release the switch, thus opening the circuit.

An intermediate lever between catch and pin operated by a sliding rule, which serves also as an index, permits of varying the point of cut-off, which has to be in a certain relation to the distance between the clamps. The position of cut-off, tension of spring, distance between clamps corresponding to each other, are marked with the same figure, which is also inscribed on a wire gauge fastened to the welder. By inserting a wire into the gauge, the number read will give the necessary adjustments at once.

If by imprudence, the switch should be moved to the right, while no stock is inserted and the clamps come in contact with each other, the switch cannot be locked and the fuse in the primary will be blown, without, however, causing any damage.

The insertion of the distance gauge between the clamps locks the switch so that the primary can only be closed after withdrawing the gauge.

The operation is as follows :

1. The wires to be welded are gauged.
2. The distance gauge and cut-off are set to correspond with the number on the gauge.
3. The movable clamp is moved to the right and the gauge inserted.
4. Both wires are securely clamped, care being taken to abut the ends squarely against the disk.
5. The gauge is withdrawn.
6. The switch is moved to the right.
7. The reactive coil is moved towards a position of minimum reaction, and restored to maximum after the weld has been completed.
8. The clamps are opened and the weld removed, after which the operation can be repeated.

If a good many welds of the same sized material are to be made, the reactive coil may once for all be set in a given position and the switch alone be operated. Welds made with the automatic machine have attained a uniformity not obtainable with the most skilled operators working without it. In fact, small, easily fusible wires can scarcely be welded with certainty with ordinary apparatus. For aluminum, especially, the automatic apparatus is needed.

The reactive device used in connection with welders is of the type recently described by Prof. Thomson, in which a case is made to more or less cover the primary, the self-induction of which is to be altered. To obtain a still larger range, the windings of the primary can be coupled in series, or multiple series, or in multiple by a switch in the base of the coil.

As mentioned before, the welding of easily fusible metals may sometimes cause a rupture of the secondary circuit, which, owing to its violence and volume of energy may cause a burn-out of the primary if not guarded against. This danger is not very great in the automatic machine, since the end pressure does not depend upon the attention of the operator. A special device is, however, used as an extra precaution against all emergencies.

Breaking a high tension circuit rapidly is not easily done. An arc generally follows the break and this lengthens the time of the rupture. If the voltage of the circuit to be broken is so low that over the slightest distance an arc cannot follow, the break will be instantaneous. This is the case with the secondary circuit of a welding transformer. The voltage being ordinarily only one volt, would, even if increased ten-fold, not be able to maintain an arc. However, multiplied in the primary it will cause E. M. F. sufficient to pierce through the insulation as ordinarily used. This action is similar to that of a Ruhmkorff coil in which the interrupter is caused to break under oil or water. This discharge is taken care of by a special apparatus, the description of which I reserve also for another communication to the Institute.

While the machine before us is only one type embodying the principal features contained in all, others have been manufactured or are in process of construction in which the automatic character has been carried out even further, as in the welding of rings and chains. I am not permitted to give a detailed account of these latter at the present time, but would say that the present model in its first form, is able to produce 250 feet of chain in a day without any attendance to speak of, the plain wire being fed into the machine at one end and the complete chain coming out at the other.

The automatic principle is, however, not confined to small conductors. We have welders with 40,000 watts output, capable of welding 1 inch copper or 2 inch iron, constructed and working daily on that plan. The projections are determined by adjustable stops, the pressure, the most important of all, is hydraulic, and regulated by an automatic reducing valve, the exhaust being used for cooling the clamps at the same time. The primary is controlled by adjustable reactive coils from a constant potential circuit and is interrupted at the proper time by the clamps. While not all machines are to-day operated on this plan, I am convinced that the evolution of the welding process tends in that direction and that the welding in future will be in the full sense of the word a purely mechanical operation. This cherished idea of Prof. Thomson's, uttered a few years ago, has well been borne out by the experience gained in actual operation on a commercial basis.

RESIDUAL DISCHARGE IN CONDENSERS.

The phenomenon of residual discharge which occurs with condensers has sometimes been attributed to an actual penetration of the electricity into the substance of the dielectric. M. Bouty, in a recent investigation of the subject, has experimented on mica condensers formed of very thin plates. It was assumed that the positive and negative electricities, soaking into the dielectric from the electrodes, would meet and neutralize each other if the plates were sufficiently thin. A constant current would therefore pass under the influence of a steady electromotive force, and the dielectric would behave like a conductor. It is a deduction from theory that for condensers having the same dielectric the product of the capacity and dielectric resistance should be constant. The experiments of M. Bouty appear, however, to disprove this law. The experiments seems to show that the conduction of dielectrics is due solely to extraneous surface leakage arising from imperfect insulation of the electrodes or to flaws in the material. M. Bouty accounts for the phenomenon of residual discharge, which causes the variations in the current on first applying the battery, to progressive change in specific inductive capacity during that time. It, however, appears easier to follow Maxwell in accounting for the separate effects by the simple assumption of a heterogeneous dielectric. In view of the great practical importance of insulators, it is desirable that these experiments should be repeated, for the results are at variance with recognized views.

THE ELECTRIC CURRENT AS A TRACTION INCREASER.

BY ELIAS E. RIES.

WITHIN the past three or four months a number of articles have been published in THE ELECTRICAL ENGINEER purporting to show, some theoretically and others by experiment, that the passage of an electric current between a driving-wheel and rail could have no effect in increasing the traction or coefficient of friction between the two surfaces in contact, and that if the current had any influence at all upon the friction it could only act to reduce the traction, instead of increasing it.

As the writer was probably the first to call general attention to the importance of increasing tractive adhesion by the direct action of the electric current, and the first to point out the laws bearing upon this subject, as determined by experiments made by him several years ago for that purpose, it may be thought proper that he should reply to these articles. It was hoped by him, however, that what he had already stated would have been sufficient to enable the intelligent reader to judge for himself as to the correctness of the conclusions arrived at by the authors of the articles referred to, but it seems that some of the writers have themselves lost sight of, if they ever understood, the fundamental principles involved in this method of increasing traction, and it, therefore, becomes necessary to describe more specifically the conditions under which this increased traction is obtained, and to briefly point out why the experiments in question failed to show what was expected of them.

It appears to have been taken for granted by many persons, probably because the phenomenon of increased traction was first observed in the operation of electric railway motors, that the mere use of the track rails as the return conductor in an electric railway system is all that is necessary in order to insure increased adhesion between the motor wheels and the rails. This is by no means the case, as the result is entirely dependent upon the nature of the current employed and the circumstances under which the current is permitted to act. As a matter of fact, the conditions existing on single trolley railways, as at present operated, are not such as to be favorable to the production of increased traction, and although a certain amount of increased adhesion occasionally manifests itself, it is not such as to be relied upon with any regularity or certainty, and is due, as will hereinafter appear, to causes entirely different from those that produce increased traction in cases where a local or independent traction circuit moving with the vehicle is employed, such as embodied in the method of electrically increasing traction patented by the writer.

In my original paper upon this subject, read before the American Association for the Advancement of Science, in August, 1887,[1] the underlying principles and conditions governing the production of increased friction by the action of the electric current were set forth for the first time in the following paragraph :—

"Before entering into a description of the means by which this result is produced and how it is proposed to apply this method practically to railway and other purposes, it may be well to give a general outline of what has so far been determined. These experiments have shown that the coefficient of friction between two conducting surfaces is very much increased by the passage therethrough of an electric current of *low electromotive force and large volume*, and this is especially noticeable between two *rolling* surfaces in peripheral contact with each other, or between a rolling and a stationary surface, as in the case of a driving wheel running upon a railway rail. This effect increases with the *number of amperes of current* following through the circuit of which the two surfaces form part, and does not materially depend upon the electromotive force so long as the latter is sufficient to overcome the electrical resistance of the circuit. This increase in frictional adhesion is principally noticeable in *iron and steel*, although present in other metallic bodies, and is due to a molecular change in the conducting substances at their point of contact (which is also the point of greatest electrical resistance in the circuit), *caused by the heat developed at that point*. * * * The most economical and efficient results have been obtained by the employment of a transformed alternating current of *extremely low electromotive force but of very large volume or quantity*, this latter being *variable at will* so as to obtain different degrees of frictional resistance."

The correctness of the principles originally set forth in the above paragraph have been repeatedly substantiated by subsequent experiments, and it will be seen therefrom that in order to produce increased traction by the direct action of the electric current, the following conditions must be observed :

1. The current must be of such volume as to produce an appreciable amount of heat at the point or points in contact.

2. The electromotive force must be as low as possible. Experiments made by the writer have shown that a high electromotive force has a tendency to *diminish* friction, especially if the pressure between the surfaces in contact is a moderate one.

3. The metals in contact should be of iron or steel, as these have the requisite electrical resistance at their contact surfaces and are of such molecular structure as to permit of a close and intimate union between them under the influence of the current.

4. One or both the metals should preferably roll upon the surface of the other. This is desirable in the first place in order to economize current by concentrating the heating effect upon as narrow a line of contact as possible. Furthermore, a rolling motion, where the line of contact moves progressively and uniformly along both surfaces, as in the case of a wheel and rail, where the contact is continually established at a new point before the old is broken, requires less current to produce a given tractive effect than does a case of sliding friction, where the surfaces move at different rates of speed and are never in fixed relation to each other for an appreciable length of time.

Let us now see whether or not these conditions have been fulfilled by those who have endeavored to show that the electric current is incapable of increasing tractive adhesion. We will then look at the matter from a more practical standpoint, and show what the electric current *has* done and is capable of doing in this direction, when properly applied.

In THE ELECTRICAL ENGINEER for May 7, 1890, Prof. Lucien I. Blake, of Kansas, describes and illustrates a number of experiments stated to have been made for the purpose of determining whether an electric current would, as stated, increase the friction between a wheel and rail in electric railways. Four different experiments are described, not one of which even *approaches* the conditions met with in railway practice. In two of these experiments such metals as platinum immersed in flowing murcury, and a brass bar sliding upon brass rails were employed! The flat surfaces in frictional contact "varied from 1⅛ to 3 square inches," an amount several times greater than the combined effective area of contact of four ordinary railway car wheels, while the current sent through these surfaces was several times less than that ordinarily used in railway practice, being but 1 ampere and 10 amperes respectively! The two remaining experiments illustrated a case of rolling or sliding friction in which the current used was presumably the same as in the first experiment—"varying from 0 to 1 ampere." In short, these experiments seem to have been devised for the express purpose of showing "how *not* to do it," since Prof. Blake himself admits, in concluding, that "the currents employed were not sufficient to produce heating at the surfaces of contact," and adds (probably after having accidentally demonstrated the fact) that "such heating would doubtless produce an increase of the coefficient of friction."

In THE ELECTRICAL ENGINEER for April 9, 1890, Mr. O. T. Crosby describes some dynamometer tests also tending to show that no increase in traction occurs. These tests were made by him with an ordinary single trolley motor car, and consisted in first returning the motor-operating current through the wheels and rails in the usual manner, and then repeating the experiments with the wheels out of circuit. The current employed was varied from 0 to 42 amperes during the experiments, and the electromotive force, though not stated, was probably 500 volts. Unfortunately the capacity of the dynamometer at Mr. Crosby's disposal was less than that needed to register the ordinary tractive effort of the car on a level track, and he found it necessary to jack up one end of the car so as "to *skid* only one pair of wheels, and to relieve these of part of their weight." It will be apparent from what has been said that the conditions under which these tests were made were not only unfavorable to the production of increased traction, but were of such a nature as to bring about the very opposite result.

There seems to be an impression among many persons that the increased traction, if present, must be due in some way to magnetic action. This view of the matter has been taken by Mr. Nelson W. Perry, of Cincinnati, in a communication published in the New York *Electrical Review* of March 1, 1890, in an endeavor to show that no appreciable increase in traction can result from the direct passage of an electric current from wheel to rail or *vice versa*, because there would not be sufficient *attractive* force produced. It was further stated that the passage of current in this manner could only result in a repellant action between the metals in contact, the author citing, among other things, the action of the electro-motograph in support of his views, and in general denying that increased traction could result by reason of *any* change, molecular or otherwise, caused in the surface of the metals by the action of an electric current, notwithstanding the fact that elsewhere in his communication he admits having witnessed an experimental demonstration in which the current *did* have the effect which he endeavors to prove it *could not* have. It is needless to state that there is not the slightest basis for any of the theoretical conclusions referred to, which in the case of this writer we will charitably assume arise entirely from a misconception of the real actions to which the increased adhesion is due.

We will now consider the part the current plays in the production of increased traction. It has already been said that this phenomena is directly due to the *heating effect* of the current upon the metals at their point of contact. A certain slight magnetic effect is necessarily also present, but this is so small in the case under consideration that it does not enter to any appreciable extent into the result, and may therefore be neglected. This heating produces a molecular change in the surfaces of the metals which causes a variation in the coefficient of friction between them, but the nature of this variation and the manner in which the increased adhesion is produced depends upon the nature of the metals and the degree of heat developed at their points of contact. As an illustration of this, it may be stated that a moderate current of sufficient strength to cause increased adhesion between iron or steel surfaces will have a lubricating effect upon brass contacts and cause a diminution of the normal friction between them, although with a sufficiently large current the friction between the latter may be increased.

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[1] See *Railroad Gazette*, Aug. 19, 1887; *Electrical World*, Aug. 27, 1887; *Scientific American Supplement*, Dec. 10, 1887.

Experiments have shown that in the case of iron and steel a comparatively slight amount of heat will serve to increase the friction to an appreciable extent, this being due to a slight expansion and elevation of the metal at one or both sides of the normal line of contact. This action is practically instantaneous, the heating effect taking place on the *surfaces* of the metals long before the bodies of the latter have had time to become sensibly warm. That the particular effect here referred to is due principally, if not entirely, to the heat, and not to the current directly, is proven by experiments made by the writer with a small electric railway model, in which the increased friction continued an appreciable length of time *after* the traction current had been cut off, the wheels of the motor car having been previously heated by the current so as to retain for a time a portion of the heat imparted to them.

The friction between driving wheels and rails is considerably increased beyond this point, however, by increasing the current strength so as to produce a still greater local heating of the metals at the point of contact, and this is the method preferred by the writer, and most economically carried out by the use of a closed traction-increasing circuit of low resistance, moving with the vehicle and including the driving wheels and that portion only of the track rails that lie between them; when the current strength is sufficiently augmented the increased traction becomes due to an *incipient welding* of the metals along the line of contact. This action leaves no permanent trace upon the wheels or rails, nor is there any appreciable increase in rolling resistance noticeable. The writer has even increased the current strength so as to produce an actual weld between the wheels and rails, without material injury to either of the rolling surfaces; in some experiments on overcoming inertia the metals separating again on the line of the weld, due to the film of oxide between them. By the employment of converted alternating current of high periodicity with respect to its volume, the heating effect may be confined to the surface of the rails without penetrating into the interior. As a rule the amount of current needed to produce a given increase in traction is found to be proportionate to the area of the surfaces in contact and, to a certain extent, to the speed of the driving wheels. The conditions under which increased traction is called for in practice are favorable to the use of a comparatively small amount of electrical energy for this purpose, since it is only in starting heavy loads and in ascending grades, when the rate of speed is much below the normal, that increased adhesion is usually required.

The writer has recently had occasion to construct a small electric motor car and track with which a number of important features bearing upon this subject have been satisfactorily illustrated. This model is still in existence, and may be seen in successful operation at the writer's office, room 27,* Chamber of Commerce Building, Baltimore, at any time. The apparatus in question consists of a small electric railway car having two driving axles insulated from each other and operated by a small electric motor supplied with current through flexible conductors in circuit with a single cell of secondary battery. The driving axles are arranged so that one of several sets of iron or steel driving wheels of different diameters can be placed thereon. The traction-increasing current is derived from an independent source and is varied according to the requirements of the experiment in hand. This current, by means of a second pair of flexible conductors connecting with binding posts on the car, is sent from the forward to the rear driving axles through the intervening driving wheels and track rails, although the arrangement is such that it can be sent directly from one rail to the other across the wheels and axles, thus enabling the terminals of the traction-circuit conductors to be attached to the rails at one end of the track, instead of being carried by the motor. The weight upon the driving wheels without extra load is about three pounds.

With this apparatus, employing a continuous traction-increasing current derived from one cell of secondary battery, the tractive effect of the motor car was increased considerably over 150 per cent., the car climbing grades of 30 feet to the hundred with perfect ease against the pressure of a spring tending to pull it backward, whereas with the same propelling current flowing through the motor, but with the traction circuit open, the car remained spinning at the bottom of a 10 per cent. grade, not having sufficient tractive adhesion to lift its own weight. Upon again closing the tractive circuit the car instantly regained its grip upon the rails and shot up the incline like a flash until its further upward progress was stopped by the distended spring and cord that secured the car to a post at the lower end of the track and prevented it from running over the top of the incline. No sparking, flashing or other visible indication that current was passing between the wheels and rails could be observed in this experiment.

There is no mistaking the action of the motor, or the important part the current plays in increasing tractive adhesion. If, while the car is ascending a steep grade, the traction-increasing circuit be opened and then again closed, the car will commence to slip backward and continue doing so with accelerated speed until the moment the circuit is completed, whereupon its descent will be almost instantly checked, and it will promptly proceed to mount the grade again as if nothing had happened.

Among other things it was shown by this apparatus, as originally predicted, that the traction is not diminished, but (compared with mechanical traction under like conditions) enormously increased when the rails are wet or slippery. The presence of water on the rails seemed to make no difference in traction while the current was passing. With the rails and wheel tires thoroughly *oiled* the car remained stationary, with the motor running at the bottom of a 6 per cent. grade. One end of the track was then elevated to form a 25 per cent. grade, and on closing the traction circuit the little car actually climbed up the slippery track as far as the spring would permit without a single idle revolution of the driving wheels!

On increasing the traction current by connecting a second cell in series with the first so as to produce a perceptible and progressive incipient welding between one or more of the wheels and rails, the tractive pull of the car on a level track, as measured by a standard spring balance dynamometer, was rapidly increased from 6 ounces, the normal pull without traction current, to 31 ounces with the current, *an increase of over* 500 *per cent!* Were it not for the fact that at this point the load and the tractive adhesion exceeded the maximum power developed by the little motor, the increased traction actually registered would have been much greater. With the same current passing between the wheels and rails the car performed the remarkable feat of ascending, without any slip, a 50 *per cent. grade, part of which was coated with oil!* This experiment has since been witnessed by a number of prominent electricians and engineers, who expressed themselves as astonished beyond measure at the wonderful increase in friction obtained, and the comparatively small amount of electrical energy required to produce it.[2]

In order to determine some of the conditions bearing upon the application of this system of increasing traction to ordinary railway train service, a series of preliminary experiments upon a large scale were made by the writer nearly a year ago with a locomotive on the Philadelphia and Reading Railroad.

These tests were made with a locomotive selected by the railroad company, a "consolidated" engine weighing 111,000 pounds (one of the heaviest and most powerful in the service of the road), of which 98,000 pounds, or nearly 50 tons, was distributed over *eight* coupled driving wheels measuring about 54 inches in diameter. The traction current was generated by a special low tension, direct-connected steam-driven dynamo mounted upon the locomotive, one terminal being connected by a heavy stranded copper cable with the forward and rear pairs of drivers respectively, which were insulated from the frame of the locomotive by special insulated brasses at the boxes and journals, the opposite terminal of the dynamo being connected with the two intermediate pairs of drivers. This arrangement was adopted to avoid interruption in the circuit at the rail joints, which on this road, as is usually the case elsewhere, were not directly opposite on both rails, but overlapped. The average resistance of the traction circuit with the locomotive at rest measured less than one two-hundredths of an ohm, practically all of which was located at the respective points of contact between the wheels and rails. The current could be varied during the different tests by varying the field strength or speed of the dynamo, or both, from about 500 amperes to the maximum output of the machine.

The first experiment was made on a substantially level track, and consisted in coupling the locomotive to a train of twelve loaded coal cars and setting the brakes on these so that the engine could not possibly start the train without continuous slipping, several unsuccessful attempts to do so being made. The dynamo was then started up and the performance repeated with *entire success*, the train being brought under full headway from a position of rest without a single slip of the wheels. This was repeated a number of times, the engineer being instructed to do his utmost to make the wheels slip while the current was flowing, as by suddenly throwing open the throttle to its widest extent with the eccentric lever in its foremost notch, etc.; but without effect. It was estimated that the load moved by the engine during this test was equivalent to a train of 110 cars.

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[2] It appears that the presence of water or oil upon the rails, as shown by these experiments, has a tendency to confine the passing current to a much narrower and smaller area of contact between the wheels and rails, thereby enabling a given current to produce a much greater heating effect at the very point where it is wanted. In other words, the weight upon the drivers is sufficient to "squeeze out" whatever oil may lie directly under the mathematical line of contact, but the film of oil or water at either side of this line offers sufficient resistance to the low tension current to confine the passage of the traction current to the exceedingly narrow portion of the wheel surface in actual metallic contact with the rail. Thus, what has always been a decided disadvantage to mechanical traction is, or may be, utilized in a most important manner in increasing traction electrically.—E. E. R.

A number of subsequent tests were made on the Frackville branch of the P. & R. R. R., upon a steep mountain grade seven miles in length, averaging 185 feet to the mile, and containing numerous sharp and difficult curves. Regular service runs were made over this grade both with and without the current, under conditions as nearly alike as the traffic over the road would permit, with entirely satisfactory results. The official records of the tests show that in nearly every instance the use of the current produced a decided increase in the tractive capacity of the locomotive, and prevented the enormous wear and tear, loss of time and consumption of coal occasioned by the excessive slipping that took place when natural adhesion alone was relied upon. On one occasion the time required to ascend the grade with a load slightly in excess of that usually carried, was, without current, 55 minutes, as against 29 minutes with the current flowing, under exactly similar conditions. The amount of coal consumed on the last named trip was *less than one-half* of that used in the trip without current, by reason of the absence of the rapid exhaust and loss of power consequent upon the slipping of the drivers.

These tests, though made under some disadvantages, were so satisfactory that they are now being continued under conditions and auspices more favorable for carrying out this work. It is estimated that the tractive adhesion of steam locomotives can by this method be increased 25 per cent., and even more in special cases, or where the construction of the locomotive is such as to permit it to utilize a greater increase. This not only means that four locomotives will be enabled to do the work that now requires five, but that longer and heavier trains can be moved, better time made, steeper grades overcome, quicker stops effected, inertia more promptly overcome and, more fuel saved than by the present methods, and what is perhaps of the greatest importance, without any material increase in the weight upon the drivers or roadbed. These and other advantages are by no means limited to steam locomotion, but apply to electric railway operation with equal or even greater force.

The question will now probably be asked: "Are the conditions existing on electric railways employing the rails as a return conductor for the propelling current such as render this current a factor in increasing the traction, and if so, to what extent?" Before answering this question let us briefly review these conditions.

In the early days of electric railways the potential difference under which the motors were operated was very small, in some cases as low as 120 volts, and the currents correspondingly large. The track rails were usually of some obsolete light weight T pattern that have done more or less service on some suburban horse railway line, and the bearing surface of which was curved to such an extent that the driving wheel contact amounted barely to a point. Under these circumstances, a useful amount of increased traction was obtainable, especially in starting the motor on a grade, when the flow of current was unusually heavy. On "single trolley" railways as at present operated, under a potential difference of 500 volts, the currents employed are not sufficiently large to produce increased traction by the *direct heating* of the metals in contact, except when, as sometimes happens, the tread of the wheel runs upon an exceedingly narrow portion of the rail surface, and even this effect is largely, if not entirely, counteracted by the high electromotive force of the current.

However, a certain amount of increased traction may be, and often is, *indirectly* produced by the current on single trolley railways. This occurs when the contact between the wheels and rails is temporarily interrupted at more or less frequent intervals by particles of sand or other foreign matter on the rails, thereby giving rise to small electric arcs and producing the "flashing" noticed under these conditions. The heat generated by these arcs is in many cases sufficient to soften the metal and to cause an actual fusing or welding action between the surfaces of the wheels and rails when they again meet beyond the grain of sand or other obstruction, the latter being sometimes vitrefied or decomposed by the arc or embedded in the heated metal. As the car moves forward, the arc, which is originally sprung behind the obstruction, advances along the wheel and rail to a point in front of it, and the points of the metal thus heated, approaching each other, unite under pressure and almost instantly cool, extinguishing the arc in so doing and producing a more or less perfect weld at the point of contact, to which the increased traction is due. The welds thus formed are again broken, during the separation of the wheel and rail surfaces on their line of least resistance, which is generally that corresponding to the original surfaces because of the film of oxide and other impurities usually found between the fused metals, and which in most instances prevents a homogeneous weld.

From this it will be seen that notwithstanding the small volume of the current on single trolley railways, an appreciable amount of increased traction may manifest itself by reason of the comparatively high electromotive force producing a slight change in the action of the current. The use, for example, of a moderate amount of sand in conjunction with the current on grades of more than usual steepness will serve to increase the adhesion both mechanically and electrically to a certain extent, but this plan is not nearly as efficient, economical, or reliable, leaving out for the present the question of its advisability, as the employment of a current of lower voltage and larger volume for the direct and uniform heating of the contact surfaces.

It may be stated in general that while it is possible to obtain a certain appreciable percentage of increased traction on electric railways in which the propelling current is returned through the wheels and track rails, and while in some few cases a slight increase is necessarily present as a function of the propelling current, yet the conditions under which such roads are usually operated are not favorable to the production of such increased traction. Numerous experiments made by the writer have shown that the most satisfactory and economical method of employing the electric current as a traction-increaser, whether on steam or electric railways, is to establish an independent low resistance circuit, including the driving wheels and so much of the track rails as lie between them, and to charge this circuit with a low-tension traction current, capable of producing the desired heating effect. As this circuit is entirely independent of, even though it may be derived from, the motive power of the vehicle, the amount of increased traction can be regulated without regard to the speed of the motor, and can also be used on down grades to assist the brakes in stopping the car. The increase in the adhesion on single trolley roads under the most favorable conditions is limited by the low heating effect of the propelling current, whereas in the case of the independent traction circuit there is practically *no* limit to the amount of increased adhesion obtainable, since this adhesion may be increased to such an extent as to actually weld or "freeze" the driving wheels to the rails.

PUBLIC CONTROL OF ELECTRIC LIGHTING.[1]

BY VICTOR ROSEWATER, JOHNS HOPKINS UNIVERSITY.

THE question of municipal control of public electric lighting involves two opposing interests. The individual, as a stockholder in a corporation disposing of its product to a city, is influenced by a policy different from that of the individual in his capacity as a citizen and a taxpayer. The former seeks to obtain the greatest possible return upon his investment; the latter is interested in keeping the cost of street illumination at its lowest limit. For the general public, then, the most important part of the discussion must revolve about the point of comparative cost under the two systems.

The business of electric lighting is now usually considered as monopolistic in its nature, and only to be engaged in after a franchise has been secured from a local authority. This privilege immediately assumes a market value, and if the plant be sold the franchise becomes an article of commerce. Why should a community grant out a privilege, valuable to others, when that privilege has the same, if not a greater, value to itself? The statistics published by the Common Council of Scranton, Pa., show that in ninety-one cities, illuminated by private electric lighting corporations, the average annual price for each arc light is $105.13, while in seventeen cities supplying their own service, the average annual cost is but $52.12½ per lamp. The same economic phenomena may be illustrated by comparing the cost of illumination to the taxpayers of two neighboring cities in Massachusetts. Danvers and Franklin have each 1,200 candle-power lamps burning every dark night until midnight. Danvers, owning its own plant, pays annually $45.37 per light; Franklin pays a corporation $80 per light yearly.

But one of the defenders of monopoly, in criticising these figures, says:

"The cost price given for all-night lighting in nine cities owning their own plants averages $53.80 per lamp per year. It is ordinarily estimated that one arc light, requiring about forty-five volts and nine amperes, consumes one horse-power at the engine. In an article in the Buffalo *Express*, April 3d, it is stated that a horse-power of steam costs $39 per year in Rochester, N. Y., $46 in Lockport N. Y., and $45 in Baltimore, Md., making an average of $43.33 per year. At this cost for steam power the difference is $10.47 to cover all other expenses of operating the electric light plants in the nine cities named. The carbons cost $5.40 per lamp per year. This will leave those cities but $5.07 per lamp per year for all other expenses, including depreciation and interest on other investment."

This calculation, so far as it is a mere assertion, may pass for what it is worth in contradiction to statistics compiled by official authority of the Scranton Council. But it is nevertheless a fact that the Brush Electric Light Company, a corporation conducted with a view to large dividends to its stockholders, recently made a bid to do the public lighting of Cincinnati at $52.40 a year for each lamp, and this is less by $1.40 than the average cost in those nine cities. Even though the Brush Company, seeing an opportunity to obtain a larger remuneration, withdrew its bid later, a bond for $50,000 was deposited at the time as an assurance that the offer was originally made in good faith.

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[1] *N. Y. Independent*, May 15, 1890.

Again it is complained that cities operating their own electric lighting plants, use buildings erected for different purposes, such as gas supply or water works; that their employés put in a portion of their time at other labor; that the superintendent is engaged in the supervision of other departments. It is sought to use these facts to impeach statistics showing the expense of these operations. But the effect is quite the reverse; for this is one of the strongest arguments in favor of municipal management of electric lighting. It shows one of the legitimate advantages which accrue from such control. Electric lighting is but one of those monopolies of service, so closely allied in character and management that their union not only promotes economy but also satisfactory service. Such industries may be conducted much more cheaply upon a large than upon a small scale. This peculiarity of natural monopolies is even being recognized by the private corporations controlling them. Gas companies are everywhere investing in electric lighting plants. It is but an indication of the strong tendency urging monopolies to combine. An instance may be cited. The Cincinnati Electric Lighting Company has just purchased a controlling interest in the five other companies located in that city. This corporation is in turn owned by the Cincinnati Gas Company. All that is still necessary to complete the industrial evolution is that the municipality itself should now step in and unite all under a city management.

It may easily be seen that prices in this industry are not governed by the cost of production. The great difference between the average cost to cities illuminated by contract and to those furnishing their own light gives good ground for this inference. But how strongly is that confirmed by the wide range in which prices charged by private corporations vary! As mentioned before, a bid was made to light the streets of Cincinnati for $52.40 annually per arc light. Peabody, Mass., pays $200 for the same service. Salem, Mass., but a few miles distant, is charged $164.25. Here is a difference of price equal to $147.60, almost 300 per cent. of the lowest offer.

The spread and propagation of these facts are rapidly bringing about the natural result. The number of cities making use of their power to supply themselves with electric light cheaply and economically is increasing with astonishing quickness. So far as known the list of cities which have already operated their own electric lighting plants for a year or more comprises: Aurora, Ill., Bangor, Me., Bay City, Mich., Champaign, Ill., Chicago, Ill., Danvers, Mass., Decatur, Ill., Dunkirk, N. Y., Easton, Pa., Frederick, Md., Grand Ledge, Mich., Hannibal, Mo., Huntington, Ind., Lewiston, Me., Little Rock, Ark., Lyons, Ia., Madison, Ind., Martinsville, Ind., Meadville, Pa., Michigan City, Ind., Painesville, O., Paris, Ill., Portsmouth, O., Topeka, Kan., Xenia, O., Ypsilanti, Mich.

Many more have taken steps in this direction, or are preparing to enter the field. During the year 1889 some twenty municipalities purchased, or took measures for the purchase of, their own electric lighting stations. Within the last few months Peabody, Mass., Sioux City, Ia., and St. Charles, Mo., have voted in favor of municipal plants; a committee of the Council in Oberlin, O., made a report advocating public control; Fort Worth, Texas, voted bonds to the amount of $125,000 for the establishment of a city plant. Chicago is extending its system, while Milwaukee, not to be outdone by her rival sister, has decided to invest $20,000 in apparatus for the manufacture of electricity. A committee of the Select Councils of Philadelphia was so highly pleased that the municipal gas works are not only paying expenses under its new management, but actually earning a profit, that it reported an appropriation of $300,000 for the extension of the public lighting system to the field of electricity. It was only owing to the influence of the electric lighting corporations that this item was stricken off the appropriation bill. This is but one of the many instances in which corporations, claiming to be ever out of politics, have turned their industrial power to use as a political force.

All these facts and figures assist in showing that monopoly is the field for public activity. Monopolistic industries, when given over to the control of private corporations, serve only to oppress and burden the citizen. This is particularly true of street illumination. Municipal management of public electric lighting tends to purify politics, and brings the citizen a cheaper service, better service, more satisfactory service.

THERMO-ELECTRIC INVESTIGATIONS.

Some experiments on thermo-electric currents between amalgamated zinc and zinc sulphate were recently described by Herr K. A. Brander. The primary object of the investigation was to determine the relation between the electromotive force developed and the difference of temperature between the electrodes. The electrodes, of amalgamated zinc were placed in two vessels communicating by means of a syphon, and filled with a solution of zinc sulphate. One of these vessel was kept at the temperature of the place of observation, while the temperature of the other was gradually raised. The *Journal* of the Chemical Society says that the author found that, within the limits of errors of observation, the electromotive force was proportional to the difference of temperature, until this difference exceeded 20.45° C., after which the electromotive force appeared to increase rather more rapidly than the temperature difference. Experiments show that concentration of the zinc sulphate solution increased the electromotive force.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.

Anonymous communications cannot be noticed.

The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.

In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the serial number of such letter, and of the page on which it appears.

Sketches and drawings for illustrations should be on separate pieces of paper.

All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, *150 Broadway, New York city.*

THE MARX ACCUMULATOR.

[127.]—In your issue of May 21, an article entitled "The Marx Accumulator" contains the following extraordinary claims:—"If an electric current is passed through a dilute solution of hydrochloric acid and perchloride of iron, in which are immersed carbon electrodes, the following reaction takes place:—$2\,FeCl_2 + 2\,HCl = Fe_2Cl_6 + H_2$. If, then, a carbon and an iron electrode are plunged into the electrolyte, the following reverse reaction, giving rise to a powerful current, takes place:—$Fe_2Cl_6 + H_2O = 1\,FeCl_2 + 2\,HCl + O$. * * * The iron electrodes are not consumed; on the contrary, on open circuit iron is deposited on them, so that they must be removed when the battery is not at work."

The first reaction, $2\,FeCl_2 + 2\,HCl = Fe_2Cl_6 + H_2$, while it is not impossible under the conditions named, is highly improbable. An electric current passing through the solution of a metallic salt tends to reduce, rather than to oxidize, the metal. This is well illustrated in the electro-deposition of nearly every known metal, including iron itself and even such highly electro-positive metals as sodium and potassium. The deposition of iron is accomplished from a ferrous salt. If a ferric salt is used, more energy is required and the ferric salt becomes ferrous as the first stage of reduction.

In the case above cited it is probable that some ferric chloride (Fe_2Cl_6) would tend to form at the positive pole, while ferrous chloride ($FeCl_2$) would be formed at the negative pole. If Mr. Marx can arrange the conditions so that H will be evolved and no O evolved, the reaction may be complete, and he will have a process identical in principle with using an electric current to assist in burning coal!

In the second reaction we have metallic iron immersed in a solution of ferric chloride. It is stated that the iron is not acted upon but the ferric chloride undergoes spontaneous dissociation with liberation of free oxygen and ferrous chloride! And that this dissociation evolves electrical energy!!

The fact is, the reaction, $Fe_2Cl_6 + H_2O = 2\,FeCl_2 + 2\,HCl + O$, cannot take place without a reducing agent which must itself become oxidized, or in some way supply energy. The reaction absorbs energy, instead of evolving it. But the metallic iron used as an electrode *is* acted upon and the following reaction is what actually takes place:

$$Fe + Fe_2Cl_6 = 3\,FeCl_2.$$

If the iron is in the form of a solid mass the action is slow in the cold, but more rapid when heated. If the iron is finely divided, such as iron reduced by hydrogen, the action is very rapid, even when cold. With free HCl present we would also have the following reaction:

$$Fe + 2\,HCl = FeCl_2 + 2\,H.$$

The free hydrogen which escapes in this reaction Mr. Marx has evidently mistaken for oxygen. The black powder of metallic iron and oxides which disintegrates with some graphite while the iron is in excess of the acid was probably thought to be "deposited" iron.

The statement that the iron electrodes are not consumed and that on open circuit iron is deposited upon them is certainly *new* and opens a wide vista. If it is true, we have the remarkable phenomenon of metallic iron precipitating metallic iron from its solutions and remaining itself unacted upon!

Orange, N. J. CHARLES J. REED.

LOWELL, Mass.— A special dispatch from Lowell, of June 1, says: A serious accident occurred Saturday night at the electric light station in Middle street, causing the sudden extinguishing of 300 arc lights in the city. Two employees were working under the shafting, when a rasping, buzzing sound warned them to fly to the next apartment. They had just got there when a heavy counter-shaft, weighing two tons, fell, demolishing the dynamos. The shaft was 23 feet long, 2½ inches in diameter, and upon it hung eight Hunter friction clutches and six belts. The damage is estimated at $2,000.

CORRESPONDENCE.

BOSTON.

Chief Inspector Goddard—A Proposed Electrical Exhibition—Report on Welding, Etc.—Whitney on the West End—A Boom In Thomson-Houston Stock—Close of the Electric Club's Season.

MR. C. M. GODDARD has been appointed as Chief Electric Inspector of the New England Insurance Exchange in place of Captain Brophy, retired.

The subject of holding an electrical exhibition in Boston during the coming autumn has been broached to representatives of several of the large electric manufacturing interests in this city, and appears to have been received with general favor. The exhibition of this nature which was held in Boston some six years ago was a fine affair, and failed only because public interest in electrical matters had not been sufficiently aroused. The case is altogether different to-day. Then electricity in the minds of the general public was more of a curiosity than a thing of the wide utility it has since been demonstrated to be. Now, when people ride in electric cars, and look with favor upon electric lights and motors, and when general interest in the matter is fully aroused, it would seem as if an exhibition, showing some of the latest and most useful novelties of the art, ought to be well patronized.

In the State Senate this week the West End Elevated Railway bill was passed to be engrossed and sent to the House. The Meigs bill has also passed the Senate to be engrossed, and some definite action may soon be looked for.

Lieut. A. B. Wyckoff, of the navy yard, Washington, D. C., who has been making a tour of inspection of several electric plants and factories, has returned to Washington, and expresses himself as well pleased with the results of his visit to Boston. The most instructive result of his trip was a careful examination of the new Thomson electric welding process as seen at their works in West Lynn, Mass. He is convinced that the process is a great success, and that it is but a question of time when the electric welders will come into general use, as doing much more rapid and perfect work than manual labor. Lieut. Wyckoff's tour of inspection was made in connection with the introduction, in the near future, of electric light and power plants at several of the navy yards

President Henry M. Whitney of the West End Railway Company was a guest of the Roxbury Club last Saturday night. His presence evoked a discussion of the rapid transit problem. Mr. Whitney delivered a lucid and exhaustive address upon street transportation. Gen. John L. Swift dealt with the passengers' side of the question, and Hon. Moody Merrill, president of the club, strongly advocated the pending West End bill for an elevated road as the only practical solution of the problem under consideration. Mr. Whitney made a clear and concise and timely statement of the many advantages to accrue from a system of electric rapid transit.

Thomson-Houston stock took a decided "boom" this week and gained five or six points at one time. Various reasons are assigned, new and important contracts, the impending consolidation, and the formation of the new debenture bond company being all fully discussed. Though somewhat premature in publication the *Boston Advertiser* makes the following statement: "The real cause of the sudden demand for Thomson-Houston stock, as exclusively given by me this morning, is the organization of the debenture company, through which it will be possible to realize cash on the securities which the T.-H. Co. takes to a large amount in payment of its work. The wide significance of this matter has not yet fully dawned on the stock market operators Last year the T.-H. Co. did a business of over $8,000,000; the indications are that it will this year do a business of perhaps $15,000,000. Call 25 per cent. of that profit and you have $3,750,000—a sum sufficient to pay dividends on $2,200,000 preferred stock and nearly $20 a share on 180,000 shares of common stock. The trouble hitherto has been that these profits, and more than the profits, have been tied up in the stocks and bonds of local companies. Given a method of realizing upon these local company securities, and the path to cash dividends is easy. This new debenture company will have a capital of $1,000,000, all or most of which will be owned by the Thomson-Houston Co. It will issue 5 per cent. debentures based on collateral bonds deposited with the American Loan and Trust Co. as trustee, $1,250 collateral being deposited for each $1,000 bond issued. The collateral bonds will bear 6 and 7 per cent. interest, and the difference in interest will constitute part of a sinking fund to redeem the 5s. The collateral bonds may likewise be sold, and the proceeds applied similarly. The debentures may be drawn at 102½ and interest. The debentures will be sold through Messrs. Lee, Higginson & Co. and Kidder, Peabody & Co., and the association of these houses with the scheme is a guarantee of success."

A careful perusal of the above statement will give some idea of the enormous growth of the electrical business,—a growth almost more rapid than it is possible to provide for in ordinary financiering. Capital in many cases of local companies, has got to be provided, and though electric light and railway stocks are well taken up, after a local company has fairly started, it is at the same time a little hard for parent companies to carry them till such a time as the stocks and bonds can be floated. The formation of the Debenture Bond Co. will largely relieve this pressure, and though, as I said, the announcement is a little premature, yet it is a fact that a company has been formed for such a purpose, on the lines indicated above.

It is also rumored that a very strong syndicate of English and American capitalists are at present investigating all the electric railways in the country, with a view to the purchase of their bonds, and their ultimate control.

The series of meetings of the Boston Electric Club, are now at an end, and there will be no more dinners or papers read until next fall. The anniversary of the club takes place on June 21st, and it is probable that an excursion to some neighboring beach may be arranged.

BOSTON, May 31, 1890.

PHILADELPHIA.

The Powelton Electric Company's Ordinance—A Denial From J. F. McLaughlin—The Telephone Agitation - Electric Railroading.

THE Powelton Electric Company's ordinance, which was objectionable to the Department of Public Works in the shape in which it passed Councils a week ago, was recalled from the Mayor's hands yesterday by City Councils and amended so as to meet the objections made against it. The bill was then passed by both Select and Common Council. In its present shape the bill provides that "nothing contained herein shall be construed to grant permission to run cars or vehicles by overhead service on any streets of the city. The city shall have the right to use the poles and conduits of said Powelton Electric Company, to attach wires thereto for municipal purposes, without cost, and all poles and wires shall be erected under the supervision and approval of the Department of Public Safety." The clause in the old bill which repealed all ordinances inconsistent with the grant to the Powelton Company was stricken out, and it is understood that the Mayor will now sign the bill. The Powelton Electric Company is chartered for the purpose of supplying light, heat and power by means of electricity to the people of West Philadelphia. For this purpose it is authorized to lay underground conduits and erect poles on any of the streets in that section of the city. The promoters of the scheme say it has not yet been decided whether to build their line underground or overhead. In the outskirts of the city the latter system will undoubtedly be used, but the company is considering whether to adopt this plan for Walnut, Chestnut, Market and other important streets. After the company is once secure in its privilege, and the great difference in the cost of the two systems is laid before its directors it will not take them long to decide which system to adopt, since there is nothing in the ordinance to prevent wires being strung along any street in West Philadelphia. City Councils have for years been struggling with the problem how to get rid of overhead wires. No new overhead lines have been constructed in several years, and the companies have all been notified that within the near future all wires must be buried. Yet in the face of this the Powelton Electric Company has been granted the privilege of erecting an overhead electric light line, and all ordinances which might interfere with this grant are repealed so far as they relate to the Powelton Company. The prohibition against overhead wires is permitted to remain so far as it relates to other companies, so that the Powelton is afforded complete protection from competition. The incorporators are :—John P. Lutz, William J. Latta, William J. Moore, Charles M. Corbin, W. W. Ingram, Samuel A. Welsh, L. A. Lee and Elliott C. Smith. Each man owns 100 shares of stock of the par value of $10, and 10 per cent. of the capital has been paid to William J. Moore, Treasurer.

The American Financial Association, to which the letter here quoted refers, suspended payment some days ago :—

ROOM 281 BULLITT BUILDING,
PHILADELPHIA, May 19, '90.

To the Editor of The Inquirer: My attention has been called to a statement in your issue of this day to the effect that they (referring to the American Financial Association) held possession of the McLaughlin Electric Company, etc.

I beg to correct you in this matter, and state that beyond the fact that Messrs. Macfarlane and Pfeiffer subscribed to and paid for a certain amount of the stock of the McLaughlin Electric Company, and by virtue thereof were elected directors, there is not, nor has there been, any connection whatever between the American Financial Association or any of its stockholders or officers and my company.

I have to add that both Messrs. Macfarlane and Pfeiffer long ago resigned as directors of the McLaughlin Company, and that the vacancies thus created will be filled by the election of gentlemen of undoubted financial standing and ability.

The McLaughlin Company is independent in every way. It has no association or affiliation with any other company in existence. *I personally control it in every way.* Very truly yours,

JAMES F. MCLAUGHLIN.

The chief result of the recent telephone agitation led by the grocers was the allowance of a rebate by the telephone company for time when their instruments were wholly useless. It was stated that the amount of rebate allowed up to date was nearly $10,000. No complaints have been made recently, and the company is making every effort to give good service, and is meeting with much success.

The East Reading, Pa., Electric Railway was opened for business last Sunday, and large crowds used the cars all day.

Experimental trips of the new electric cars on Market street, Camden, N. J., were made on the eastern section of the track a few days ago. It is understood that everything worked satisfactorily.

PHILADELPHIA, May 30, 1890.

ST. LOUIS.

The Municipal Electric Lighting and Power Company.—Important Work on the Lindell Electric Railway.—Electric Railway Work.—Emerson McMillan's Schemes.—Miscellaneous.

The Municipal Electric Lighting and Power Company have increased their capital stock from $750,000 to $1,500,000, the result of which has been the purchase of the St. Louis Illuminating Company. This places the Municipal Company in absolute control of all the arc lighting in the city and also the incandescent commercial lighting by the Heisler system, supplied by the original station of the old St. Louis Illuminating Company.

The only competitors of the Municipal Company are the Missouri Electric Light and Power Company—Westinghouse incandescent—and the electric station of the Laclede Gas Co.—Brush and Heisler incandescent systems—and it is likely that one or both of these will finally be absorbed by the Municipal Electric Lighting and Power Company. The Municipal Electric Lighting and Power Company are controlled by a syndicate composed of Seligman & Co., and Ladenburg, Thalman & Co., of New York, and James Campbell and Mortimer F. Taylor, of St. Louis. John O'Day, president of the company, is the representative of Seligman & Co. The company have also increased their bonded indebtedness from $750,000 to $1,500,000. Statutory statements for this purpose, filed in the recorder's office, show, assets, $1,645,000; liabilities, $1,379,000.

The Lindell Railway Co. have begun the erection of their new power station on Compton avenue. The new station will have an aggregate capacity of 3,600 h. p., one-half of which will be ample for the operation of 215 cars, and will be installed this summer. The remainder of the plant will be added as the traffic demands. The boiler room, 100 x 78, will be fitted with 20 Rohan Bro.'s boilers, 72 x 18, with 4 inch tubes, $\frac{1}{2}$ inch shell and $\frac{5}{8}$ inch heads. Coal will be supplied from a track running through the centre of the building, the boilers being arranged in two rows on each side of the track. The floor of the boiler room will lie some 6 feet below the railway track so that the coal can be fed into the furnaces almost by gravity. The engine and dynamo room cover a ground space of 115 x 89 feet, 24 feet in the clear, with trussed roof and turret skylight for ventilation and leading in mains. The walls are of St. Louis pressed brick with stone trimmings; the inside walls will be faced with finished brick. The floor will be granitoid. Two traveling cranes, each of 5 tons capacity, will be provided for moving dynamos or engines. Eight Armington and Sims compound engines, each of 400 h. p. at 100 pounds pressure and 245 revolutions, will be supplied and erected by E. P. Hampson & Co., of New York. The generating plant will consist of 16 new pattern Edison No. 60 compound generators, each of 150,000 watts capacity, belted direct to the engines. All interior wiring of the station will be run clear of the walls and flooring. The overhead plan of wiring will be used. The dynamo leads and the outside mains all land on two switch tables located in the centre of the room, the tables being centrally located between the eight generators.

The trolley wires will be supplied by the Aluminum Brass and Bronze Co., of Bridgeport, Conn. All high grade rubber insulated wires for feeders and mains will be supplied by the New York Insulated Wire Co., of New York, and fibre insulated wire by the Edison Machine Works. The railway company are erecting their poles and doing their own track wiring. The general contract for line material and fixtures and the erecting of the entire outside electrical work is being carried out by J. G. White, of the United Edison Manufacturing Co.

One hundred motor cars are being constructed by J. G. Brill & Co., of Philadelphia. The cars will be fitted out at the car shops, with interior electrical conduit tubing furnished by the Interior Conduit and Insulation Co., of New York.

A fully equipped machine shop for general repairs is being fitted up at the old car stables on Choteau avenue. The entire plant and equipment was planned jointly by J. H. Vail, chief engineer, of the Sprague Electric Railway, and J. A. McClure, superintendent of motive power, Lindell Railway Company.

The Motor Company filed articles of incorporation on the 19th of April, with a capital stock of $10,000, one-half paid up. The incorporators are James Campbell, E. McMillan, J. C. Van Blarcomb, John Scullin and Robert McCulloch. It now transpires that the object of this company is to experiment with Connolly gas engines, one of which will be received about the middle of June. It will be tried on the Benton-Bellefontaine Road, of which Jas. Campbell is president. The Connolly gas engine was tried by the Missouri Railroad Co. several years ago, and at that time proved to be a very unmanageable piece of fireworks. The inventors now claim to have developed a practical machine

Emerson McMillan, president of the Laclede Gas Co., has gone to Europe, ostensibly for his health, but it is generally known that his object is mainly to interest English capitalists in a scheme for controlling gas industries in the United States. The United Gas Improvement Co., of Philadelphia, who control the Laclede Gas Co., of St. Louis, the Kansas City Gas Light Co. and the gas companies of Burlington, Iowa, and Atlanta, Ga., and also the Heisler system of incandescent lighting, have lately sold out to an English syndicate for $10,000,000. Mr. McMillan's trip will probably result in increasing the capitalization of the syndicate to the sum of $50,000,000. One-half of this sum has already been subscribed by the American members of the syndicate.

A bill has been introduced before the Municipal Assembly, authorizing the St. Louis Conduit Company to construct and operate conduits for electrical purposes.

The bill authorizing the lighting by electric lights of all parks except Tower Grove and Lafayette parks has passed both branches of the Municipal Assembly.

The Vandeventer Avenue R. R. Co. have filed bond for $10,000, also an acceptance of their franchise for an electric railway.

The St. Louis Cable and Western Road is advertised to be sold by special commissioner, June 20th. The road embraces 16 miles of narrow gauge steam road extending from Vandeventer avenue to Florisant Village and a cable division in the city proper some three miles in length. The road will probably be purchased by the newly organized Central and Western, who have a franchise for an electric extension from the junction of the steam and cable divisions to Forest Park.

Mr. Charles A. Benton, special agent of the Sprague Electric Railway Co., made a short stay in this city and reports the closing of a contract with the Greenlawn and Glenwood Road at Columbus, Ohio, for an equipment of five cars.

The East St. Louis Electric Railway Co. have elected officers as follows: G. W. Allen, president; H. F. Bader, vice-president; P. J. Doer, treasurer, and A. D. Sexton, secretary.

Lebanon, Mo., by an almost unanimous vote, has accepted a proposition for electric lighting, and work on the $100,000 hotel and bath house at the magnetic well will commence at once.

The Metropolitan Electric Railway Co., of Springfield, Mo., have been incorporated with a capital stock of $500,000. The new Westinghouse Electric Railway Co. have secured the contract for the equipment of this road.

ST. LOUIS, May 31, 1890.

PITTSBURGH.

Patent Litigation—Allegheny County Light Company's Work—Electric Railway Work.

UNITED STATES Commissioner Gamble has been in this city for the past week. Testimony was taken before him in the United States Court in a suit between the Edison Electric Light Company and Westinghouse, Church, Kerr & Co., of New York. The case has been pending in the courts of New Jersey for some time, involving an alleged infringement of a patent used for the distribution of electricity. The testimony taken went to show that the invention had been used in Pittsburgh prior to the time Mr. Edison claims to have invented it.

The first cars for the Oakland and Linden Grove Electric Railway company have arrived in this city and the road will be in operation within a few days.

Among the latest improvements made by the Allegheny County Light Company of this city is a photometer room which is somewhat of an innovation as an accessory to a central station plant. The company has given this experiment a thorough test and finds it a most useful part of its outfit. The company not only tests the vacuum and candle-power of all new lamps, but also returned lamps are examined, and if the carbon is found to be still intact and in pretty good order, the lamp is put into use again. Over one hundred lamps are thus tested each day.

The new switchboard of the company has quite a number of advantages, but it recommends itself especially for its compactness, the facility with which everything can be handled and its systematic arrangement. The board consists of two separate parts, a lower front part which is smaller, and a larger one arranged behind, covering an entire wall. On the lower front portion of the switchboard are the dynamo regulators for eight 3,000 light Westinghouse alternate current dynamos. Behind and above this are the circuit regulators for twenty circuits, capable of carrying two thousand lights each. There are also three three-thousand light machines of the company run from the Allegheny branch of this station through the same switchboard, making space for a total machine capacity of 33,000 16 c. p. lights.

The management of the Second Avenue Electric Railway Co. of this city is about to build a system of electric street car lines which will be the longest in this part of Pennsylvania. It is projected to run the company's West End line from this city direct to Grafton and Mansfield, a distance of ten miles. The West End line is still operated by horse cars, but the change of motive power is to take place this summer. When the latter road is finished, the company will be able to carry its passengers from Homestead direct to Mansfield, a distance of twenty miles.

General Manager Blaxter, of the Allegheny County Light Co., will leave for England in a few days. Mr. Blaxter will visit his boyhood home in Devonshire and naturally looks forward with keen pleasure to the coming trip.

PITTSBURGH, May 31, 1890.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the last meeting of the Council of the Institute, on May 20, the following gentlemen were elected to associate membership:—

Bunce, Theodore D., Jr., battery expert, the Julien Electric Traction Co., 239 E. Twenty-seventh street, New York city.

Brooks, Morgan, secretary and treasurer, St. Paul Gas Light Co., St. Paul, Minn.

Peck, Edward F., general sup't, Citizens Electric Illuminating Co., cor. Navy street and DeKalb avenue, Brooklyn, N. Y.

Jones, F. R., sup't of construction, the Western Engineering Co., Kearney, Neb.

Bradley, Fred W., United Edison Mfg. Co., 65 Fifth avenue, New York.

Bell, Dr. Louis, Editor *Electrical World*, 167 Times Building, New York.

Williams, Arthur S., electrician, American Telephone and Telegraph Co., 18 Cortlandt street, New York city.

Storey, Imle E., electrician and manager, Storey Electric Drill and Power Co., 16 Broad street, New York city.

Watts, H. Franklin, electrical engineer, Altoona, Pa.

Lozie, Robert T. E., Electrical expert, the Edison United Mfg. Co., 65 Fifth avenue, New York.

Sweet, Henry N., chief of Patent Bureau, Thomson Electric Welding Co., 89 State street, Boston, Mass.

Marks, Louis B., graduate student, Cornell University, Ithaca, N. Y.

Total, 12.

THE NEW JERSEY POSTAL TELEGRAPH COMPANY.

New Jersey and New York capitalists have incorporated a new telegraph company for New Jersey, to be known as the New Jersey Postal Telegraph Company. The promoters of the company are principally residents of Orange and Newark, N. J. The corporators are Everett Frazar, Francis R. Upton and Henry P. Winter, of Orange; Philip Lowry, of Newark; Joseph A. McClary, of Rahway, and Edward Alden, of New York. The paid-up capital stock of the company is $50,000, which will be increased as necessity arises. The President of the company is Everett Frazar.

The company will be operated in close connection with the Postal Telegraph Company of New York, favorable arrangements therefor having been concluded with John W. Mackay. The company will thus be in connection with all parts of the United States and Canada, and through the Mackay-Bennett cables with Europe. About 100 miles of lines will be built at once, running through Newark, the Oranges, Elizabeth, Rahway, Plainfield, New Brunswick, Perth Amboy, Keyport, Matawan, Middletown, Red Bank, Long Branch, Asbury Park, Ocean Grove, and later on every town in New Jersey. Newark is already wired, an existing system there having been purchased. The general manager of the business in New Jersey, with offices at Newark, will be Mr. McClary, at present the manager of the Postal Telegraph Company's Wall street office. The office of the President of the company will be at No. 124 Water street, New York city. The Treasurer and Secretary of the company will be Mr. Alden. It is the intention of the company to give the people of New Jersey a far better service than they now have—a quick and trustworthy day and night service—with special advantages for news matter. There will be no cutting of rates against the Western Union, the chief advantages to be offered by the new company being the superior service which will be guaranteed. It is because the Postal Telegraph Company of New York has not cut rates that it remains the only competitor of the Western Union Telegraph Company. The New Jersey Company has acquired the right to the use of a new patent printing telegraph instrument, and all its despatches will be printed.

MR. G. C. SIMS, of the Armington & Sims Engine Co., Providence, R. I., has been chosen by the Governor of Rhode Island, as one of the State World's Fair Commissioners. The selection is not less admirable than it is popular.

REPORTS OF COMPANIES.

THOMSON-HOUSTON COMPANY.

The Thomson-Houston Company shows this summary of gross sales and profits, also the orders for electric motors and generators for the three months to April 30, 1890, compared with 1889, it being the first quarter of the fiscal year:

	1890.	1889.	Increase.
Gross sales	$2,133,099	$1,139,833	$993,266
Profits	$650,724	$299,613	$351,111
Motors ordered	1,106	247	859
Generators ordered	112	16	96

AMERICAN BELL TELEPHONE COMPANY.

The American Bell Telephone Company reports a net increase in instruments of 469 for the month ended May 20, and an increase of 1,124 for five months. The comparative figures follow:

Month May 20.	1890.	1889.	Inc.
Gross output	6,938	5,902	1,036
Returned	2,135	1,568	567
Net output	4,803	4,334	469
Since December 20.	1089-90.	1888-9.	
Gross output	25,819	23,705	2,114
Returned	10,177	9,187	990
Net output	15,642	14,518	1,124

The total number of instruments in use May 20 was 460,503.

SUB-COMPANIES OF THE ERIE TELEPHONE SYSTEM.

The Cleveland Telephone Company, the Northwestern Telephone Exchange Company and the Southwestern Telegraph & Telephone Company report for the year ending March 31, 1890:

Gross income	$721,860.47
Gross expenses, including dividends paid	719,258.98
Surplus	$2,601.49

SUBSCRIBERS.

Number connected March 31, 1889	11,315
Added during the year	930
Total number connected March 31, 1890	12,245
Proportion of earnings and dividends received by the Erie Telegraph & Telephone Company	$225,061.73
Dividends paid (four) of $48,000 each	192,000.00
Surplus	$33,061.73

The statement of assets and liabilities March 31, 1890, shows:

ASSETS.

Licenses	$2,300,000.00	
Stocks	2,500,000.00	
Unissued treasury stock	200,000.00	
Cash deposits for unpaid dividends	1,471.00	
Accounts receivable	1,351.37	
Cash in banks and loaned at interest	67,660.65	
		$5,070,483.02

LIABILITIES.

Capital stock (par value $100)	$5,000,000.00	
Unpaid dividends	1,471.00	
Surplus	69,012.02	
		$5,070,483.02

COLLEGE NOTES.

Harvard University.

Fleming's *Alternate Current Transformer* has been used as text book in Physics IV. (Electrodynamics) during the last half year. Dr. Fleming's systematic treatment of his subject is very pleasant to the students after their attempts to follow the intricate reasonings of Maxwell. The summaries in the first few chapters are especially helpful in showing the connection between different parts of the subject.

Prof. B. O. Pierce has recovered from his illness, and resumed his classes in Mathematics and Physics at the close of the April recess. Every one is glad to have him back again.

In the course of some delicate experiments, some time ago, it was found impossible to keep the instruments perfectly steady. The independent brick piers on which they were placed were shaken enough by railroad trains half a mile away, and by the men exercising on the ball grounds near by, to disturb seriously the very delicate apparatus, so that it was possible to work only a few hours at midnight, when everything was still. This trouble was finally remedied by placing on the pier a large flat stone, weighing about half a ton, separated from the pier by thick pieces of rubber. The rubber took up the vibrations perfectly, and the experiment was made, indifferent alike to railroads and to base ball players.

At the annual election of officers of the Electric Club, held May 21st, the following were the successful ones, those marked (*) being reëlected. *President*, G. H. Chittenden, '91. *First Vice-President*, *E. H. Lewis, L. S. S. *Second Vice-President*, A. N.

Barron, '91. *Secretary*, H. C. Smith, '93. *Treasurer*, *A. N. Barron, '91. *Librarian*, *G. T. Page, '92. *Members at large of the Executive Committee*, W. R. Westcott, '92; *G. S. Curtis, '92; P. W. Davis, '93.

At the previous meeting of the club Mr. A. N. Barron, '91, read an interesting paper on Storage Batteries.

LEGAL NOTES.

BREACH OF CONTRACT, ETC.—W. K. FREEMAN *vs.* U. S. ELECTRIC LIGHTING CO.

Walter K. Freeman's suit in the New York Supreme Court against the United States Electric Light Company for $100,000 damages for alleged breach of contract and balance of salary came on for trial last week before Judge Ingraham, who dismissed the complaint, holding that the alleged contract with Charles R. Flint, the president of the company, was not binding, as it was not shown that he had authority to make it.

THE RIGHT TO OPERATE A ROAD ELECTRICALLY.

TAGGART VS. NEWPORT, R. I., STREET RAILWAY CO.

This was the suit to enjoin the defendant from operating its road electrically. The Supreme Court of Rhode Island in denying the injunction say:

"The street railway here complained of is operated neither by steam nor horse-power, but by electricity. It does not appear, however, that it occupies the streets or highways any more exclusively than if it were operated by horse-power. The answer avers that 'electricity, besides being as safe and as easily managed as horse-power for the propulsion of street cars, is more quiet, more cleanly, and more convenient than horses, both for residents on the streets used by said cars, and for the public generally, and also causes much less wear and injury to the streets and highways than is occasioned by street cars of which horses are the motive power.' These averments, the case being heard on bill and answer, must be taken as true. We see no reason to doubt their truth. It is urged that electricity is a very dangerous force, and that the court will take judicial notice of its dangerousness. The court will take judicial notice that electricity, developed to some high degree of intensity, is exceedingly dangerous, and even fatally so, to men or animals, when it is brought in contact with them; but the court has no judicial knowledge that, as used by the defendant company, it is dangerous. The answer denies that it is dangerous to either life or property. It is also urged that the cars, moving apparently without the application of external force, alarm and frighten horses. This so far as it is alleged in the bill, is denied in the answer. We see no reason to suppose that this form of danger is so great that on account of it the railway should be regarded as an additional servitude. The answer alleges that a great many street railways operated by electricity, in the same manner as the railway of the defendant is operated, are in use in various towns and cities in different states, and that many others are in process of construction. Reference has been made to cases which hold that telegraph or telephone poles and wires erected on streets or highways constitute an additional servitude, entitling the owners of the fee to additional compensation; and from these cases it is urged that the railway here complained of is an additional servitude, by reason of the poles and wires which communicate its motive powers. There are cases which hold as stated, and there are cases which hold otherwise. But, assuming that telegraph and telephone poles and wires do create a new servitude, we do not think it follows that the poles and wires erected and used for the service of said street railway likewise create a new servitude. Telegraph and telephone poles and wires are not used to facilitate the use of the streets where they are erected for travel and transportation, or, if so, very indirectly so; whereas the poles and wires here in question are directly ancillary to the uses of the streets, as such, in that they communicate the power by which the street cars are propelled. It has been held, for reasons which we consider irrefragable, that a telegraph erected by a railroad company, within its location, for the purposes of its railroad, to increase the safety and efficiency thereof, does not constitute an additional servitude, but is only a legitimate development of the easement originally acquired. *Telegraph Co.* v. *Rich*, 19 Kan., 517. Our conclusion is that the complainants are not entitled to the relief prayed for on the ground alleged; and that the bill be dismissed with costs."

BOOKS RECEIVED.

Rules Which should be Observed in Employing Electric Currents for use in Electric Lighting, Transmission of Power, Telegraphy, Telephony and Signalling. Compiled by George H. Benjamin, M. E., Ph. D. New York, 1890.

INVENTORS' RECORD.

Patents issued May 27, 1890.

Alarms and Signals:—*Burglar-Alarm*, E. Hayward, 428,774. *System of Circuits for Electric Semaphores*, F. Stitzel, 428,970.

Clocks:—*Electric Circuit-Closer for Clocks*, H. C. Karr, 428,676. *Electric Programme Clock*, J. L. McCaskey, 428,854.

Conductors, Conduits and Insulators:—*Electric-Cable*, W. L. Candee, 428,745. *Electric Insulator*, G. B. Watson, 428,979. *Support for Electric Lights and Conductors*, C. H. Simmons, 429,067. *Underground Conduit for Electric Wires*, E. L. Witthaus, 429,104.

Distribution:—*Reactive Coil*, H. Lemp, 428,620. *Turn-off for Alternating Current Circuits*, E. Thomson, 428,647. *Alternating Current Magnetic Device*, E Thomson, 428,650. *System of Electrical Distribution*, E. Thomson, 428,651.

Dynamos and Motors:—*Regulator for Dynamo-Electric Machines*, E. Thomson, 428,705. *Electric Motor and Generator*, F. J. Sprague, 428,732. *Brush-Holder for Dynamo-Electric Machines*, F. A. Weller, 428,735. *Commutator Collector or Block for Dynamo-Electric Machines*, C. F. Brush, 428,742 and 428,743. *Electric Motor or Dynamo-Electric Machine*, S. M. Potter and H. E. Morgan, 428,782. *Electric Motor*, R. M. Hunter, 429,094.

Galvanic Batteries:—*Method of Preparing Battery Zincs*, J. H. Mason, 428,684. *Galvanic Battery*, J. S. Nowotny, 428,781. *Solution for Galvanic Batteries*, E. M. Burt, 428,888.

Lamps and Appurtenances:—*Process of Manufacturing Carbons*, C. Heisler, 428,604. *Incandescent Lamp Socket*, E. Thomson and G. H. Alton, 428,652. *Electric-Light Hanger*, C. L. Jeffers, 428,723. *Suspension-Hanger for Electric Lamps*, E. P. Morris, 428,929. *Holder for Electric Arc Lamps*, J. Pawlowski, 428,492. *Globe for Electric Lamps*, W. H. Wilson, 428,989.

Measurement:—*Method of Measuring Electric Currents*, E. W. Rice, Jr., 428,633. *Electric Meter*, E. Thomson, 428,649. *Galvanometer*, A. E. Colgate, 428,746.

Medical and Surgical:—*Male Genital Electrode*, A. R. Somerville, 429,068.

Metal Working:—*Sliding Clamps for Electric Welding Apparatus*, H. Lemp, 428,616. *Electrical Apparatus for Welding Rings*, H. Lemp, 428,617. *Method of Welding Rings by Electricity*, H. Lemp, 428,619.

Miscellaneous:—*Double-Pole Switch*, G. H. Alton, 428,586. *Transformer for Heavy Currents*, H. Lemp, 428,618. *Casing for Induction Coils*, E. Thomson, 428,648. *Electric Switch*, E. Thomson, 428,704. *Register for Gas-Meters*, L. Ehrlich, 428,900. *Electric Switch*, J. F. McLaughlin, 428,935. *Watch Demagnetizer*, F. F. Ide, 429,033.

Railways and Appliances:—*Guard-Wire Protector and Lightning Arrester for Electric Railways*, E. Thomson, 428,658. *Electric Locomotive*, E. Dummer, 428,669. *Device for Maintaining Electrical Connection Between Separate Railway Trains*, D. M. Fike and J. Huffman, 428,748. *Electrically Propelled Vehicle*, A. A. Ingraham, 428,917. *Suspension for Trolley Wires*, E. P. Morris, 428 930. *Device for Suspending Electric Conductors*, H. I. Pierce, 429,058. *Staff Apparatus for Controlling Traffic on Single-Line Railways*, F. W. Webb and A. M. Thompson, 429,074. *Electric Railway*, R. M. Hunter, 429,093.

Secondary Batteries:—*Process of Assembling Secondary Battery Electrodes*, J. F. McLaughlin, 429,049.

Telephones and Apparatus:—*Machine for the Manufacture of Wax-Coated Tablets for Graphophones*, G. S. Taintor, 428,646. *Single-Cord Multiple Switch-Board System*, C. E. Scribner, 428,698. *Coin-Actuated Attachment for Phonographs*, L. Glass and W. S. Arnold, 428,750 and 428,751. *Attachment for Telephone Desks*, B. Schram, 428,818. *Coin-Released Telephone Lock*, H. L. Cassard. *Process of Resurfacing Phonogram Blanks*, O. P. Austin, 429,079.

D. VAN NOSTRAND COMPANY.

D. Van Nostrand Company, 23 Murray and 27 Warren streets, this city, have issued a notice that in consequence of the appearance (ignoring the right of the English author) of a reprint of "Bottone's Electric Bells and All About Them," they have reduced the price of the English edition from $1.20 to 50 cents.

ROSE POLYTECHNIC INSTITUTE.

THE Rose Polytechnic Institute, an advertisement of which appears in the present issue, is one of three or four schools in the United States which are especially devoted to the education of civil and mechanical engineers. One of the peculiar features of the Institute is the thorough and extensive "shop practice" of the students in mechanical engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over forty thousand dollars. It also pays no little attention to electrical engineering, and is doing good work in that field.

ORGANIZING AN ASSOCIATION OF PHONOGRAPH COMPANIES.

WHILE it may not be of direct interest to electrical engineers, the recent gathering of the phonograph interests in Chicago is one that cannot be passed by without notice. The convention in question, held last week, was composed of licensees of the North American Phonograph Co., and no fewer than 31 such local companies were represented. The meeting was held in the Auditorium Hotel and lasted through Wednesday and Thursday, evening sessions being also resorted to. Among those present were Jesse H. Lippincott, president of the North American Phonograph Co.; Samuel Insull, representing Mr. Edison and the Edison Phonograph Works; Mr. Charles Cheever; Col. Sampson and no fewer than 60 or 70 of the officers of local companies throughout the country.

While to many it seems a matter of surprise that interests still unfamiliar to the public should organize, there can be no doubt that the business-like proceedings and the largeness of the gathering impressed everyone with the fact that the phonograph industry is destined to take a commanding position. Not a few of the men present had passed through the pioneer work in the introduction of the telephone and the electric light; and all were of the opinion that the phonograph to-day is much further advanced, and is, industrially speaking, in a far more healthy condition than were those great applications at a parallel stage of their career.

It is needless to add that a large number of questions connected with the introduction of the phonograph were discussed, the main idea being the adoption of uniform apparatus and uniform methods throughout the country.

The great and interesting feature of the meeting was the use of the graphophone and the phonograph for reporting the proceedings. This was done by the graphophone on Wednesday and the phonograph on Thursday. As fast as the sentences were uttered by each speaker they were repeated into the machine, and thus not a word was lost. It is claimed that the superior qualities of the phonograph in recording and reproducing were remarkably exemplified in this performance, it being possible to dictate to that instrument in a far lower tone than was possible with the graphophone. The results obtained were so perfect and so striking as to open up an entirely new era and field in verbatum reporting. Even accomplished stenographers often find it impossible to keep up with fast speakers, although they may afterwards be able to write out a straight record; but with the phonograph the "recording angel" soon gets the knack of repeating to the machine the words he hears; and he is the quicker to do this if he has had the peculiar training of the memory that is so much an element in the success of the efficient stenographer. The report on Thursday on the phonograph was taken by between 30 and 40 cylinders, which were, of course, immediately ready to be placed in the hands of typewriters for transcription in the ordinary manner. The method followed for repeating, in "taking down" the discussions, was to have two instruments ready, side by side, and simply to move from one to the other, the filled up cylinder being taken off and replaced while the other was being "charged" on the machine in service. This process was as easy to perform as it is to describe and was carried on throughout the sessions without a hitch.

Before dispersing the convention organized formally and permanently, and elected president, secretary, treasurer, etc. Regular meetings will be held, and the membership will be restricted to local companies, as in the case of the National Telephone Exchange Association, a body whose rules and methods have been approximated to by the new Association.

It is believed that without delay the work of stenographic or verbatim reporting will undergo a radical change in this country, as one result of the convention, and that the phonograph with its tireless little electric motor will be the means by which all the legal proceedings, public meetings, debates in Congress, etc., will be recorded.

THE COX METHOD OF CONVERTING HEAT INTO ELECTRICITY.

THE following interesting item of news is from the *Hartford Courant*, of May 31: "For fifty years electricians have been trying to discover a method of converting heat directly into electricity. Until recently no results of commercial value have been obtained. Such a method seems now to have been discovered or invented by a young man from Maine, H. B. Cox. If Mr. Cox's claims are just—and capitalists have confidence enough in them to have formed a company with a capital of $1.000,000—the whole system of power and lighting will be revolutionized and steam will be regarded as too expensive for ordinary uses.

"As has been said, a company has been organized and incorporated in Maine, where Mr. Cox was when some Hartford men met him. Since then the business has all been brought to Hartford, and all that has been done since has been done at the factory of the Pratt & Cady Company. The capital stock is $1,000,000, and none of it is now for sale. Francis A. Pratt, of the Pratt & Whitney Company, is the president; R. N. Pratt, of the Pratt & Cady Company, is vice-president, and Ernest Cady, of the same company, is the treasurer. E. Henry Hyde, of Hyde & Joslyn, is a stockholder, one of the directors, and legal adviser of the new company. All the patents asked for by Mr Cox have been allowed, and they will be issued in a few days. Both foreign and domestic patents have been applied for.

"Before the company was formed Mr. Cox had a furnace at home by which he ran many electric lights. This furnace was injured in being transferred to Hartford. and a new one of the same size has not yet been completed. Experiments and private exhibitions have been conducted here on a smaller scale, but in a short time the company intends to show to the world that with the power thus obtained anything that steam or electricity now does may be done. Several members of the company saw what could be done with the furnace of Mr. Cox before any attempt was made to remove it. The one now being built will be an improvement on the old one, and the results from it are expected to be correspondingly better.

"Most of the stock of the company is owned in Hartford. Some of it is held in Boston. The whole affair has been kept secret until the company should be ready to make it public. Even now the officers of the company are unwilling to talk for publication, but gossip about the new invention has been so frequent in Hartford and elsewhere that it seems proper to print a general statement. The officers of the company say they will be ready for public exhibitions in a few weeks."

THE PULLMAN-WESTINGHOUSE RUMORS.

With regard to the rumors that have been current of an alliance between Mr. George Westinghouse, Jr., and Mr. Pullman, a Chicago paper says:

"The visit to Chicago of George Westinghouse, Jr., who is at the Auditorium Hotel, is said to be in connection with a plan which George M. Pullman and he have been considering for some time for the formation of a company for the construction and equipment of electric street railways. Mr. Westinghouse has a new electric motor and Mr. Pullman is said to be building a car adapted to its use. An exhibition of the electric apparatus was given in Pittsburgh not long ago and the interest then manifested by Mr. Pullman led to the plan for the company's formation. A visit to New York by the two persons most interested led to the promised purchase by capitalists of a large quantity of stock in the new concern when it shall have been chartered. It is probable that the articles of incorporation will be taken out in Pennsylvania. It is not thought that a special plant will be built at present for the construction of the cars and motors, although one object of Mr. Westinghouse's visit to Chicago is to consult about the feasibility of building motor works at Pullman. In a conversation on the subject Mr. Pullman said the selection of a site at Pullman would be of benefit to him and that he regarded the proposition favorably. A new air brake for use on electric cars has been invented and arrangements for its manufacture made at the Wilmerding, Pa., works, and as the motors are now making at Pittsburgh it will be seen that the company will be ready to begin operations immediately on the granting of the charter. Mr. Pullman denied the rumor that a plan for the union of all the street car lines in this city is under consideration; also the one to the effect that a new line was to be built."

MARSHALL FIELD'S WESTERN ELECTRIC PLANT.

Amongst the numerous large isolated plants in Chicago, one of the most important is that which is lighting Marshall Field's magnificent wholesale department building, which could no more dispense with its electric light plant than with its elevators, so important a factor is a cool, powerful and non-destructive light in establishments of this kind.

The electric plant comprises 8 Western Electric Company's arc dynamos, 6 being of 30 light capacity each, and two of 25 lights. These machines are running 212 arc lamps throughout the building, and give a beautifully soft and at the same time powerful light. In addition to the arc lighting machines, are 2 Edison incandescent dynamos, each capable of generating a current of 300 amperes, which at present run some 580 20 candle-power incandescent lights. All the dynamos are run by two Buckeye engines, at present giving 143 h. p., each under a pressure of 70 lbs. by means of countershafting to which they are belted, and steam is obtained from 8 tubular boilers, five only of which are employed during the summer months, three furnishing steam for the above engines and the remaining two operating the elevator engines and furnishing the steam necessary for heating the building. The plant is run all day continuously, and with the greatest satisfaction. Each of the two engines operates one-half of the plant, 5 of the dynamos being coupled to each engine, thus rendering extinction of the light by a breakdown impossible. Mr. Naylor is the chief engineer and electrician, and great credit is due him for the very excellent way in which everything about the whole plant, even to its minutest details, is maintained, and to which its thoroughly successful operation is so largely due.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

FITCHBURG STEAM ENGINE COMPANY.

The Fitchburg, Mass., Steam Engine Company, through Mr. W. E. Sheldon, their treasurer, write us as follows:—"We are running full time and have a large number of orders on hand. We are building engines now for the Springfield Milk Association, Springfield, Mass.; two engines for the Falulah Paper Co., Fitchburg; engine, boiler, etc., for Shirley, Mass.; engine for Standard Thermometer Co., Peabody, Mass.; are putting in a large high speed engine for Orange Electric Light Co., Orange, Mass.; are building one 100 h. p. and one 20 h. p. engine for a large paper mill in Delaware; are just about to start a 50 h. p. engine in the Vanderbilt Building, Beekman St., N. Y., for running their electric lights; are also building a pair of cross compounds for the North Adams Gas Light Co.; also 150 h. p. engine, boilers, shafting, etc., for a large brick concern in Missouri; are just starting a 200 h. p. engine, boiler, condenser, etc., for a large paper mill in Birmingham, Conn.; have recently shipped 50 h p. engine to parties in Springfield, Ohio; also 60 h. p. engine to Frontenac Paper Co., Dexter N. Y.; are building 100 h. p. engine for Bourn, Hadley & Co., Templeton, and recently started a complete outfit for a brick company, in Millville, N. J.; also recently shipped engine to Central America, and are sending our engines all over the world."

PROCEEDINGS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The proceedings of the National Electric Light Association at its recent conventions held at Niagara Falls and Kansas City, will be published shortly by the association in two handsomely gotten up volumes. A limited number of pages have been reserved for advertising, and those desiring representation will do well to make arrangements at once for space, with the Manufacturers' Advertising Bureau and Press Agency, 111 Liberty street, New York, who, we are informed, have entire charge of this portion of the work.

QUEEN & CO.

Philadelphia has the reputation, with some, of being rather slow and conservative, but it is interesting to notice that Queen & Co., the well-known Philadelphia makers of electrical test instruments, have pushed vigorously beyond their surroundings and are building up a wonderful business in their line. Until within the last two or three years, practically all the measuring apparatus used in this country was imported from abroad, a popular feeling existing that the value of an instrument was enhanced if a foreign name appeared on it. We are glad to say, however, that such is not the case now. Queen & Co., for example, have demonstrated that they can make electrical test instruments at least equal in quality to the best of foreign makes and as reasonable in price. They are finding customers for their standard resistance boxes, portable testing sets, ammeters and voltmeters and their other specialties in all parts of the United States, and have even had inquiries from abroad. They report a recent large sale to the Northwest, comprising Ayrton & Perry instruments, portable testing sets, Cardew voltmeters, tachometers, etc., to the amount of about $1,500. This is a sample of the demand for their apparatus. We are informed that a new and enlarged edition of their catalogue 166 is in the printer's hands now. It will pay all who desire a copy to correspond with them.

ORDERS FOR EUREKA TEMPERED COPPER.

The Eureka Tempered Copper Co., of North East, Pa., having removed into their new brick plant, report an increased and permanent business for the last sixty days. Among their orders for electrical work during this time, they report good orders from the following manufacturers and plants:

St. Paul City Ry. Co., St. Paul, Minn.; Card Electric Motor & Dynamo Co., Cincinnati, Ohio; Sperry Electric Co., Chicago, Ill.; Brush Electric Co., Cleveland, O.; Westinghouse Electric Co., Pittsburgh, Pa.; Brush Electric Light Co., Buffalo, N. Y.; La Roche Electric Works, Philadelphia, Pa.; Quaker City Electric Co., Philadelphia, Pa.; Rhodes Mfg. Co., Philadelphia, Pa.; Jeffrey Mfg. Co., Columbus, Ohio; Electro-Dynamic Co., of Phila., Philadelphia, Pa.; Riker Electric Motor Co., Brooklyn, N. Y.; Tufts College, Boston, Mass.; Belding Motor & Mfg. Co., Chicago, Ill.; Thomson-Houston Electric Co., Lynn, Mass.; C. & C. Electric Motor Co., New York.; Wenstrom Consolidated Dynamo and Motor Co., Baltimore, Md.; Standard Electric Co., of Vermont, Boston, Mass.; Eddy Electric Mfg. Co., Windsor, Ct.; National Electric Mfg. Co., Eau Claire, Wis.

The use of pure copper without alloys, hard enough for electrical work, appears to give satisfaction and solves a problem that has retarded electrical progress for some time. It is well worth investigation by all electricians who desire durability, perfect conductivity, etc., for commutators, brush material, gear pinions or bearings.

THE PORTER BOILER MANUFACTURING COMPANY.

The Porter Boiler Manufacturing Co., is the name of a new corporation which has succeeded to the business of Porter, Jackson & Co., of Chicago. They have opened fine new offices in the Rookery, and are doing lots of business. Their factory is situated at South Chicago, and their large shops there are equipped with the latest and most improved machinery, thus enabling them to furnish the finest boilers at reasonable prices and very promptly. Among the tools which they have purchased from the best makers in the country may be mentioned the 20-foot rolls, whereby they are enabled to make 2-sheet boilers up to that length. They have also a hydraulic riveting plant of the latest patent, and an improved spacing table together with other new and fine machinery. This company manufactures boilers and accessories of all sizes, of the finest workmanship and finish.

THE GREAT WESTERN ELECTRICAL SUPPLY COMPANY.

The Great Western Electrical Supply Co., George Cutter, manager, are rapidly getting settled in their new and handsome quarters at 190–192 Fifth avenue, Chicago. Carpenters and cabinet makers are very busily engaged in building bins and receptacles for the various electrical supplies which will be carried, and constructing office partitions and the like. The whole of the first floor will be used as a store, surpassing in size anything heretofore attempted in the supply line, where all kinds of goods will be handsomely displayed. The offices which are situated on the second floor will be finished in oak and fitted out with every possible convenience for office work on a large scale. Mr. Cutter has secured the services of an able and well-known electrician to take charge of his house-goods department. Some remarkably large orders have already been received during the last few days, which notwithstanding the present somewhat unsettled state of affairs consequent upon change of quarters, have been filled with old-time promptitude and despatch. Mr. Cutter, although very conservative in his remarks, feels that he is warranted in saying that he is now fitting up and filling with goods, a building which will be the largest electrical supply house in America in the very near future.

SOME NEW WESTINGHOUSE PLANTS.

The following are among the recently established central station electric light plants operating the Westinghouse alternating current system: Grafton, W. Va., 500 incandescent lights; Lebanon, Miss., 500 incandescent and 40 arc lights; Emaus Borough, Pa., 25 arcs; Negaunee, Mich., 25 arcs.

Laconia, N. H., has recently shown her enterprise in the organization of an electric light company, which has since awarded the contract to the Westinghouse Electric Company for the furnishing of alternating current apparatus of 1250 lights capacity.

The Salem Electric Light, Heat and Power Company, of Salem, N. J., after having, for nearly three years, been running a very successful incandescent plant has just decided to go into the arc lighting business also, in order to meet the great demand which is made for that method of illumination. The Company has just contracted with the Westinghouse Electric Company for one of its new arc machines.

The Electric Light and Power Company of San Antonio, Tex., has been in operation since 1887, and it was one of the first in this country to adopt the Westinghouse alternating current system. The company has lately been obliged to make some enlargements in the plant and added new Westinghouse apparatus of 850 lights capacity.

The Westinghouse alternating current apparatus for central station plants has been installed in the following places outside of the United States and Canada: London, England, 25,000 lights; Canton, China, 1500; Halifax, Nova Scotia, 1400; Havana, Cuba, 4500; Juis de Fora, Brazil, S. A., 1500; Santa Anna, Salvador, C. A., 500; Sansonate, Salvador, C. A., 500; Shidsnoka, Japan, 1500; Vancouver, B. C., 750.

The Westinghouse alternating current incandescent system has now been established in nearly three hundred central station plants throughout the country with a total capacity of almost six hundred thousand 16 c. p. lamps. Of these stations the following have a capacity exceeding 1000 lamps: Albany, N. Y., 1300; Allegheny, Pa., 13,000; Allentown, Pa., 1500; Amherst, Mass., 1500; Annapolis, Md., 2250; Aspen, Col., 1400; Auburn, Me., 2250; Austin, Tex., 5200; Baltimore, Md., 5000; Batavia, N. Y., 1250: Bath, Me., 1400; Bay City, Mich., 1500; Beaver Dam, Wis., 1300; Binghamton, N. Y., 3000; Birmingham, Ala., 1000; Boston, Mass., 3750; Bristol, Pa., 1000; Buffalo, N. Y., 3250; Butte, Mont., 2250; Carbondale, Pa., 2050; Cedar Rapids, Iowa, 2050; Chattanooga, Tenn., 1960; Clinton, Ill., 1400; Colorado Springs, Col., 3450; Columbus, O., 2600; Conshohocken, Pa., 1300; Connelsville, Pa., 1500; Cornwall, Ont., 1300; Council Bluffs, Ia., 2250: Dansville, N. Y., 1000; Denison, Tex., 1500; Dennison, Ohio, 1000; Denver, Col., 16,800; Des Moines, Ia., 1000: DuBois, Pa., 1000; Duluth, Minn., 2800; Eau Claire, Wis., 1300; Elmira, N. Y., 1500; Englewood, Ill., 2250; Flint, Mich., 1150; Evansville, Ind., 1300; Fort Worth, Tex., 2300; Galveston, Tex., 1300; Greensburg, Pa., 1350; Hagerstown, Md., 1300; Halifax, N. S., 1400; Hamilton, Ont., 2000; Hartford, Ct., 4750; Helena, Mont., 1500; Hoboken, N. J., 1300; Kansas City, Mo., 3000; Kansas City, Kan., 1500; Lincoln, Neb., 1950; Little Rock, Ark., 2250; Louisville, Ky., 3000; Mansfield, O., 1400; Mauch Chunk, Pa., 1500; Media, Pa., 1500; Minneapolis, Minn., 4500; Moline, Ill., 1500; Montgomery, Ala., 1300; Morristown, N. J., 1300; Nashville, Tenn., 5500; Newark, N. J., 2250; New Bedford, Mass., 5800; Newburg, N. Y., 1500; New London, Ct., 1400; New Orleans, La., 6500; New York, N. Y., 53,500; Oakland, Cal., 1300; Ottawa, Ont., 1500; Oxford, O., 1000; Parkersburg, W. Va., 1950; Peekskill, N. Y., 1300; Philadelphia, Pa., 2700; Pine Bluff, Ark., 1300; Pittsfield, Mass., 2650; Pittsburgh, Pa., 26,450; Pittston, Pa., 1200; Plainfield, N. J., 3900; Plattsburg, N. Y., 1500; Port Jervis, N. Y., 1400; Portland, Ore., 6000; Pottsville, Pa., 1500; Providence, R. I., 7500; Pueblo, Col., 2800; Richmond, Va., 6950; Salem, N. J., 1000; Salem, O., 2050; San Francisco, Cal., 1300; Sandusky, O., 1300; Saratoga, N. Y., 1500; Savannah, Ga., 3350; Schenectady, N. Y., 4100; Seattle, Wash., 1500; Sheffield, Ala., 1300; Sing Sing, N. Y., 1300; Sioux City, Ia., 1400; Skaneateles, N. Y., 1500; Springfield, Mass., 4300; Springfield, O., 1950; Stapleton, N. Y., 5300; Sterling, Ill., 1000; Steubenville, O., 2250; St. Joseph, Mo., 3750; St. Louis, Mo., 15,000; St. Paul, Minn., 4100; Tampa, Fla., 1150; Torrington, Ct., 1300; Trenton, N. J., 3900; Troy, N. Y., 1300; Tyrone, Pa., 1700; Washington, Pa., 1250; West Superior, Wis., 1500; Wheeling, W. Va., 1950; Wilmerding, Pa., 1500; Williamsport, Pa., 2250.

NEW THOMSON-HOUSTON ELECTRIC RAILWAYS.

The Thomson-Houston Electric Company has recently finished the equipment of the following roads on which cars are regularly running: Georgetown and Tenalleytown Street Railway, 6 cars and 6 miles; Vancouver, B. C., Electric Railway, 4 cars and 3.50 miles; Utica, N. Y., Belt Line Railway, Utica, N. Y., 25 cars and 20 miles; Milwaukee, Wis., Cable Company, 12 cars and 15 miles; Knoxville, Tenn., Street Railroad, 5 cars and 3.40 miles; North Side Railway, Fort Worth, Texas, 15 cars and 15 miles; Attleboro, North Attleboro and Wrentham Street Railway, 5 cars and 6.50 miles; the Albany Railway, Albany, N. Y., 32 cars and 14 miles. The power station at Albany is one of the finest which has been built for electric railway purposes. It is a substantial brick building, divided by a brick wall into two rooms, one containing the battery of boilers and the other the engines, generators and electrical appliances. The boilers are ten in number, and have a total of 1,250 horse-power. There are six engines of 200 horse-power each. The generators are twelve in number, two being belted direct to each engine, and are capable of producing 80 horse-power each. The boilers, engines and dynamos rest upon brick foundations, which are supported in beds of concrete two feet in thickness, which obviate entirely all tendency to vibration which is usually found in the operation of heavy machinery. The plant throughout in every detail is constructed in the most thorough and substantial manner, and this, not less than the motor cars, has given the utmost satisfaction since the start. The power house was designed by, and built under the direction of, Mr. L. H. McIntire, the engineer of the Thomson-Houston Railway Engineering Department.

The San José and Santa Clara Railway, San José, Cal., just started, is interesting, not only from its excellent construction, but because it is the first railway in California equipped with the Thomson-Houston system. The road consists of nine miles of track, on which the double overhead construction has been used, and will operate six double motor cars.

NEW ENGLAND TRADE NOTES.

The Wright Electrical Engineering Company have commenced work on the outside construction for the North Adams, Mass., Electric Light Company, who are at present changing over from their old station to the new one. There are in all about 68 arc lights, and about 11 miles of street circuit. The Wright Company will do all the electric work in the station. The Wright Company has also prepared plans which have been accepted for the new station at Taunton, Mass., to take the place of the one which was burned down a few weeks ago. Plans have also been prepared and accepted for Clinton, Mass. The Wright Company recently secured the contract for a 100-light isolated plant for the factory of B. S. McDonald, Boston, and will take charge of the whole construction.

DETROIT TRADE NOTES.

Detroit Motor Company.—Under the successful management of Mr. F. A. Blades this company have so outgrown their present quarters as to have found it necessary to buy ground for the erection of a new and larger factory. The demand for the motors seems to be general.

Detroit Electrical Works.—The new factory of this company is now ready to be occupied, and the removal of machinery, tools, etc., will be completed by July 1st, at which time the business will be pushed harder than ever—if possible.

Detroit City Lighting.—Now that the Detroit Electric Light and Power Company have secured the city contract for lighting the streets of Detroit, the towers owned and operated by the Brush Company will be unused. Speculation is rife over the effectiveness of the pole lighting as it will be carried on by the new company, and the knowing ones say that the towers will be in darkness only till the expiration of the new contract. The Brush Company, in the meantime, are making special preparations to fill the increasing demand for house lighting, and Manager J. E. Lockwood is busy with the details of the increased plant he will install.

WESTERN TRADE NOTES.

Anti-Magnetic Shields. The B. & O. R. R. Co. have adopted the anti-magnetic shield, manufactured by Giles Bros. & Co., as a protection for the timepieces of their employees. This action has been rendered necessary by reason of the very extensive use that they are making of electrical apparatus and appliances. They are also installing the Giles time service in all their principal depots, and have appointed Giles Bros. & Co., of Chicago, as chief inspectors, with a competent staff of sub-inspectors.

The Chas. Munson Belting Co. have recently taken some very large orders for their famous "Eagle" and "Dynamo" belting, some of which run into miles. They have greatly enlarged their factory, increasing its facilities one-third, and now take in Nos. 22–36 on South Canal street. The additions comprise four more floors in the adjoining building, which they are now fitting out with the latest and most approved machinery for the manufacture of their belting specialties. They have acquired an immense reputation for the high class of their goods and the general excellence of their manufactures. They have been compelled to take these steps to cope with their rapidly increasing business, and meet the increased demands with promptness and despatch.

Mr. George Kelley, the inventor and manufacturer of the World's Fair Wire Link Belt, has issued a handsome circular with cuts and descriptive matter pointing out the advantages of his new belting. The advantages claimed for this wire link belting are strength, durability, flexibility, economy and perfection. It is formed of spiral wire links, which are made flat from one inch to three inches wide, coupled together with steel rods. These rods work in horizontal sockets running parallel with the rod, making the link a perfect hinge. These links are not round spirals, flattened, nor are they flat oval, but they are spirals wound flat and set to keep their proper shape to receive the rods which couple them together, or, in other words, to have the proper socket for the rod to work in. The wire used in these links ranges from No. 8 to No. 12, giving the desired strength, and the belt is capable of being run perpendicular, horizontal and twisted, quarter, half or three-quarter turn. It is the easiest belt in the world to lengthen, and this is accomplished simply by the removal and insertion of a rod. It is specially adapted for dynamo work for the following reasons: On a long horizontal stretch, the belt is perfectly straight on the bottom, with a graceful curve turning over the top of the pulleys and the belt running comparatively slack, showing no strain on the belt whatever, and it is equally adapted for any other work where a belt is used.

Shay, Stephens & Co. are quite busy filling the demand for their glass insulators and battery jars. These specialties have gained a reputation to be envied amongst the trade, and their employment is increasing largely all the time.

Mr. Geo. P. Nichols, the Western agent of the stationary motor department of the Thomson-Houston Co., is sending out notices of his forthcoming marriage with Miss Mabel Nobles, of Aurora, Ill., event to take place on June 3d. We desire to congratulate them heartily and wish them many long years of happiness.

The Charles Munson Belting Co., through their New York branch, have just sold a large order of their famous belting, comprising 1,200 feet of single and double "Eagle belting," for use in Brazil, S. A. They are extending their business to all parts and its growth is entirely due to the great excellence of the product which they turn out. Another of their recent orders is one to the American Wire Works, Cleveland, O., of 300 feet of 44 inch three-ply "Eagle" belting.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

Geo. M. Phelps, President. F. R. Colvin, Treas. and Business Manager

Edited by
T. Commerford Martin and Joseph Wetzler.

New England Editor and Manager, A. C. Shaw, Room 70—620 Atlantic Avenue, Boston, Mass.
Western Manager, W. F. Collins, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada, - - - - - - per annum, $3.00
Four or more Copies, in Clubs (each) - - " 2.50
Great Britain and other Foreign Countries within the Postal Union " 4.00
Single Copies, - - - - - - - - .10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* The Electrical Engineer. *Communications for the attention of the editors should be addressed*, Editor of The Electrical Engineer, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

Vol. IX. NEW YORK, JUNE 11, 1890. No. 110

I have, I think, universally found that the man whose mind was by nature or self-education fitted to make good and worthy suggestions was also the man both able and willing to work them out.—Faraday.

ELECTRIC LOCOMOTIVES IN RAILWAY WORK.

THE large and increasing number of electric street railways now in successful operation having definitely settled the question of their practicability, notwithstanding the misgivings expressed by many who are wedded to the older methods of propulsion, the next stage in the development of electric railroading is undergoing an experience similar to that through which its precursor has passed. The operation of the main lines of railway by the same methods, some time since hinted at in a general way, is now receiving active and serious discussion by electrical engineers; and recent essays on the subject, such as the magnificent paper of Mr. O. T. Crosby, read before the American Institute of Electrical Engineers, have placed the subject in strong relief as a problem involving by no means extraordinary conditions, but, on the contrary, requiring only the application of well defined engineering and economic principles. That this is becoming more generally recognized may be gathered from the fact that journals devoted to the steam railway service which have heretofore remained entirely silent on the subject, on the assumption of its utter impracticability, have recently taken it up for comment and criticism. Thus in a recent number of *The Railway Review* we note an article on this subject which is worthy of attention as indicating some of the aspects of the question as seen from the steam railroad man's point of view. While the writer of the article admits the success of electric propulsion on short lines where traffic is heavy, or on suburban lines in the vicinity of large cities, the statement is made that "when the cost of the stationary engines, dynamos, motors and electrical circuits can be reduced to the amount now necessary to furnish the same power with locomotives there will be chance for the electric motor, but not until then." There was a time, when, we believe, this argument would have been a valid one, but numberless instances can be pointed out that prove its fallacy in the present case. We believe that the investor of the present day considers less the first cost of an enterprise than the prospective increased gain on the outlay, from the most economical apparatus. We see this principle applied daily in the investment of thousands of dollars in coal saving devices by steam users, who, by the application of ordinary business principles, recognize that the reduction in the amount of their coal bills far exceeds the interest on their investment to effect that reduction. This very principle has perhaps more than any other effected the transformation of numerous horsecar lines into electrical roads, the companies operating the former having wisely spent sums aggregating many millions in addition to their present investment in order to secure an increased revenue. The reduction of the cost of the electrical equipment to that of the present steam equipment of a railroad is therefore by no means a paramount condition to be fulfilled.

We read further in the article referred to: "It is pretty certain that at present there are no manufacturers who are ready to build and guarantee electric motors large enough to take the places of the locomotives of to-day, and if they ever do build motors of that size and sell them to railways they must be contented with smaller profits than they now make." With the knowledge of the work which is now being accomplished in dynamo and motor construction we do not hesitate to say that an electric locomotive of the size and power described would at once be forthcoming on a demand for it. Indeed, we are convinced that a contract calling for such a machine would elicit a number of bids with ample bonds for the proper execution of the work. We make this statement not only as a result of our past observation, but because we have recently inspected plans of an electric locomotive of the power designated, which will probably be carried into execution at an early day.

The reduction in the cost of the electric locomotive which our contemporary insists must come about before its adoption can become general, is based on the calculation that an electric locomotive, costing at the rate of $20 per horse power, is twice as dear as a steam locomotive of the same power. In the absence of any definite estimates on the subject, it seems futile to enter into a comparison on this head, but it is more than probable that the estimate given above for the electric locomotive can be largely reduced.

But granted even an increase of first cost, the same rule of economy already pointed out holds in this case. Our contemporary also takes up the question of the method of equipment to be adopted, and shows the difficulties which would be encountered in the attempt to apply a separate motor to each car. So far as this method of operation is concerned, we do not recall an instance in which it has been seriously proposed for regular railway traffic. True, Mr. Frank J. Sprague proposes to furnish the elevated railway cars in New York City with individual motor equipments, but this plan is dictated, he considers, by the strength, or rather the weakness, of the elevated structure which does not permit of a concentration of load on the drivers of a locomotive capable of handling 6-car trains as proposed. We are therefore prepared to agree entirely with our contemporary that if electricity is to be used to move railway trains it must be made to conform in many features to present practice, which is the result of many years of experiment and successful application. Electrical engineers yield to no one in their admiration of what has been accomplished by steam railroad engineers, but they have an unshakable conviction that in electricity they have a better motive agent than steam for a very large proportion of railroad work.

SAFETY DEVICES AND CUTOUTS.

The difficulties with which the early workers in the field of electric lighting had to contend, and the innumerable safety devices which were invented to overcome them, would make an interesting volume indeed. There is, in fact, hardly a property of the current which has not, in some way or another, been called into play in the operation of an electric safety device; and individual properties have been varied in numberless ways to effect the desired end. Among these the heating effect of the current is probably the one most generally employed in a cutout and the fusible plug is probably justly considered to be the most reliable and simple device of this nature when properly proportioned. But it has come to be recognized that if the fuse can be assisted in its work by some means that will insure its quick action, additional security will be attained. An ingenious device of this nature is the air space cutout designed by Mr. W. J. Jenks, and described in another column. Relying upon the "jumping" power of the current, Mr. Jenks inserts an air space of corresponding width in the path of the circuit, which, acting in conjunction with the fuse or other device, makes the action of the latter certain.

We are very glad to see the great attention, thus indicated, now being paid to the question of safeguarding circuits that carry small currents against invasion by heavy currents. The matter is one of the highest importance. Indeed, we sometimes think that it is one of the points in which even a little legislation would be beneficial; but probably, before long, the universal opinion among electrical engineers will enforce the rule that no apparatus of whatever class shall be without its appropriate "safety" device. The cost of such insurance will be insignificant in comparison with the immunity secured from danger.

Electric Motor Launches.

One of the features of boating on the Thames, above London, has been the use of electric launches, current for which is furnished from storage batteries. These launches have now been shown also at the Edinburgh Electrical Exhibition, on the adjacent Union Canal, and have excited very favorable comment. It is a little surprising that nothing of the kind has been seriously attempted here, if only on the lakes of the larger parks of such cities as New York and Brooklyn. Perhaps the main difficulty lies in the rarity of charging stations, but there are ways to overcome that. If nothing of any magnitude can be done before 1892, then it is to be hoped that at that time visitors to the World's Fair will find a whole flotilla of electric launches awaiting hire, not only in the parks, but on Lake Michigan itself.

Electric Hoists on Docks.

The application of the electric motor to the loading of vessels alongside docks, though evidently within reach, has up to the present been practically neglected, owing no doubt to the enormous development of, and attention absorbed by, the other branches of motor application. We are therefore pleased to see that a start has been made in the direction mentioned by the installation of an electric hoist on a dock in Brooklyn, in which it is principally employed in the loading of cotton. The highly inflammable character of this material, and the general inhibition against the employment of boilers and steam engines on docks, makes this installation one of note, and sets an example which will be largely followed in the near future. Our progressive friends in the South, especially, would do well to keep this application in mind.

The Permeability of Iron.

The study of the magnetic properties of iron has of late years been taken up with renewed vigor, and as a result some of the theories of magnetism thus far offered to account for the phenomena observed are gradually undergoing modification, while others are becoming untenable in the light of modern research. Any research which can throw some light on the nature of magnetic action is therefore of special value at the present time, and hence the results obtained by Mr. A. E. Kennelly, as embodied in an admirable essay on another page, will be read with interest. In this original research, Mr. Kennelly arrives, at least in one case, at the fact that the permeability of wrought iron at right angles to the direction of magnetization is relatively increased. With the observed phenomena as a basis, Mr. Kennelly discusses the various theories of magnetism now in vogue, and proposes another which is designed to reconcile the discrepancies existing in them as they now stand.

Friction on Dynamo Bearings.

The excellent workmanship which is now being bestowed on the manufacture of dynamos and motors has effected considerable economy in the power absorbed by these machines, but it may not be amiss to call attention to the fact that improvement in some directions is still desirable. Where motors, for instance, are coupled directly to the machine to be driven, the loss in friction at the bearings will, under any condition, be comparatively small, but with the transmission effected by means of belting, the loss in friction at the bearing may, under certain conditions, be comparatively high. This is well shown in the results of experiments in this direction given in another column, in which it is shown that under a light load the existing forms of bearings may absorb quite a large percentage of the total power developed by the machine. Too much stress must not, of course, be laid on conclusions based on a single series of tests with only two bearings compared, but the results reached plainly demonstrate the necessity of lessening, so far as it can be done, the friction of the journal bearings of dynamos and motors.

THE JENKS AIR SPACE CUTOUT.

The evolution of methods for street lighting by incandescent lamps has developed more than one device in which are apparent no little ingenuity and the results of years of experience. The most of these apply either to current regulation of series circuits, where several loops are operated in parallel from one dynamo, or to the preservation of the continuity of any series which may tend to become broken by the rupture of the most delicate and practically the only destructible portions of the circuit, namely the lamp carbons.

As by the normal operation of the system these incandescent bridges burn out one after another, the rise of the potential at the terminals of each dying lamp tends to form an arc across the consuming ends of the carbon loop at the point of rupture, and one of the most difficult problems which has presented itself has been to suppress this arc before its vicious action could destroy the carbon terminals, eat its way through the seal and possibly melt the base of the lamp and the mechanism of the socket into a heterogeneous mass.

The first plan adopted by the Edison Company in the operation of the "municipal system" was to shunt each lamp and its socket by a high resistance magnet. Upon a material increase of potential above that normally expended in the carbon, such as would result from a decided tendency to break the circuit in the lamp while burning, or from a connection with a dynamo of 1,000 volts after the circuit had been accidentally opened in the lamp or its socket, this magnet would attract an armature, which by a locking mechanism was made to securely close a short circuit. The main difficulties with this device arose from the unreliability of any apparatus involving mechanically moving parts exposed to the moisture of the out-door atmosphere and seldom operated, and from the fact that a rupture of the carbon, the most obvious and frequent cause of increased resistance and consequent rise of potential, usually developed an arc of a resistance hardly greater than that of the carbon loop itself, and sometimes actually less.

After a long series of most interesting experiments, Mr. Edison applied to the lamp a principle which he had used very early in the art in connection with a current regulator, and later (in 1883) as a potential indicator. A third wire is sealed into the stem between the leading conductors, its inner terminal extending into the vacuum space a short distance, and its outer end connecting with a fusible wire holding a short-circuiting spring in tension. During normal action this middle wire carries no current, but when an arc occurs between the carbon clamps a portion of the current is taken up by the intermediate channel, and melts the fusible wire, liberating the spring and closing the circuit around the lamp.

The great importance of this continuity of a series circuit has necessitated the addition of a second or reinforcing cutout in the socket, and for this a very effective and cheap device was in 1885 arranged in the form of a "film" or "paper" cutout, an application of the old telegraph lightning arrester, in which a sheet of paper was interposed between a line plate and an earth plate, and when punctured by a disruptive spark, short-circuited the instruments. In order, however, to render the film reliable it was necessary to use paraffined paper or some other moisture-proof equivalent, and to make the operation certain at comparatively low pressures, say 500 volts, it was essential to use a thickness of about $\frac{1}{1000}$ inch. This frail barrier was so often broken through as to become troublesome, and after about three years of practical work an improvement was seen to be indispensable.

This was presented in an arrangement for which a patent has just been granted to Mr. W. J. Jenks. It involves the principle of another old form of lightning arrester, similar to the first, excepting that an air space takes the place of the film of mechanical insulation, so far as to form the path for the disruptive spark. It is a curious fact that the resistance of an air space, though practically immeasurable by any of our most delicate instruments, is overcome by a lower potential than an equal thickness of mica, paper or other mechanical insulator, which is so much better as a conductor as to be readily measured by an ordinary bridge.

Taking advantage of this Mr. Jenks has adopted the ordinary plate lightning arrester to the uses of electric lighting, power, telephone, telegraph, burglar alarm, fire alarm, and other circuits employing, or likely to conduct, either atmospheric or dynamic currents, by enclosing or separating the surfaces by a wall of refractory material, such as mica, or lava, which is also practically moisture and dust proof. This method of enclosing within an isolated cell, the air space which is to be relied upon to form the track of the current, is found by careful experiment to be absolutely essential in dealing with the low potentials from which delicate instruments must be protected, and the very close adjustment required to provide for a short-circuiting action with a predetermined potential may be secured by several methods. For the purposes of the "municipal system" it is sufficient to bring the opposing conducting surfaces within about $\frac{3}{1000}$ inch of each other, while for other uses it may become necessary to narrow the space to about $\frac{1}{2000}$ inch.

Evidently adjustments as delicate as these can in practical work be made by the ordinary operative only by interposing between the electrodes a distance piece or washer of definite thickness, having one or more holes through which the discharge will occur, and this distance piece forms one of the most important points of the invention. It may consist either of mica, of perforated paper, silk bolting cloth or other suitable perforated film. By its means it is easy to set this potential cutout so that a rise of pressure from 150 to 200 volts, or even from 75 to 100 volts, will operate it with certainty, and cause the shunt to carry, either as a dead-short circuit or through a compensating resistance to the line beyond, or to ground, as the case may be, the normal current which might otherwise be broken, or the accidental current from some high pressure circuit, which might injure the instruments, and interfere with the circuits.

The accompanying engraving, Fig. 1, shows the air space cut-out as applied to an Edison "municipal" lamp, and Fig. 2 shows its construction. As will be seen, it consists simply of two plugs, L and L′, which are screwed into the sleeve K, against a washer *n*, of insulating material, which has an aperture; the air space thus formed constitutes a bridge across which the current passes when the potential exceeds a given amount corresponding with the width of the air space.

One of the best evidences of the utility of this device is the fact that several thousand have been in satisfactory use on the Edison "municipal" circuits in this country for about two years.

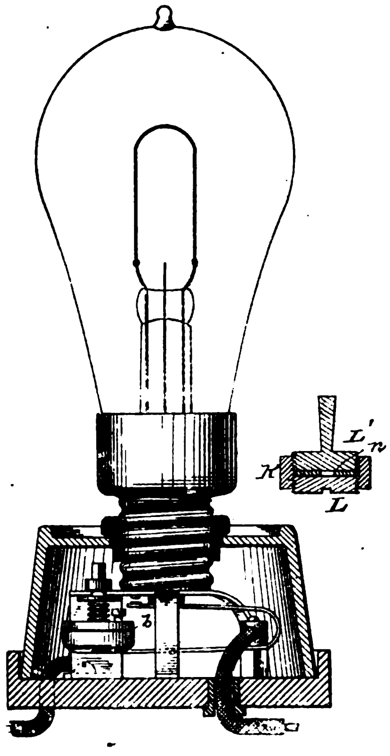
A more important application of the idea was shown at a recent test before the Underwriters of New England, of a large number of devices proposed for adoption as protectors of telephone and other "innocuous" circuits from the effects of accidental contacts with high pressure wires. While many of the forms of apparatus then submitted operated promptly to open a grounded circuit even by the application of abnormal currents of low amperes, the air-space cutout (or some equivalent device) in combination with a fuse, electro-magnetic or other circuit-opening apparatus, was pronounced by the insurance inspectors to be absolutely essential to the safety of the instruments, operators and patrons of metallic circuit systems likely to become crossed with high pressure lines.

The application of the air space cut-out to a grounded circuit is shown in Fig. 3. Here a telephone wire T comes into electrical contact with a point C in an arc circuit. If no leakage to earth has previously existed on the arc circuit, no current will, of course, flow through the telephone line in consequence of this contact. If, however, another path exists, as at G, a difference of potential will be at once set up between the point at the cross C and the point where the telephone line is grounded at E, causing a current to flow through the line T, the fuse, and either the bell B or the telephone, according as one or the other may be in use.

If the air space cut-out at A S be so applied as to form a path or shunt around the instrument with a break of a small fraction of an inch air space, the difference of potential, if amounting to a predetermined standard of, say, 100 volts, to which the plates of the air space cut-out have been adjusted, a disruptive spark will bridge this air space and establish a sufficient connection between the plates to allow of a continuous flow of current through the fuse for a sufficiently long interval of time to melt it and open the circuit. This action will probably take place simultaneously at both ends of the line, or at a point beyond the cross where a similar fuse and cutout have been placed.

Thus the central station, or any intermediate office, would be protected as well and as promptly as that of the customer.

This combination of air space cut-out and fuse produces for metallic as well as for grounded circuits a result more sure, so far as the melting of the fuse is concerned, than can be secured with a fuse alone. The existence of a cross with any high pressure wire, or with any wire whatever capable of producing a predetermined difference of potential of moderate degree, as 50 or 100 volts, between the telephone circuit and the earth, instantly results in a disconnection of the portion of the line within the building from that outside.



Figs. 1 and 2.—The Jenks Air Space Cutout.

With any device operating merely to break the circuit by means of the flow of an abnormal current, and which does not respond to a rise of potential with respect to the earth, no indication or warning would necessarily be received of such a cross until by some means, as by an accidental contact of a person operating the telephone with one of the binding posts of the receiver and a steam, gas or water pipe, the circuit would be completed.

It is evident that the protection of complete metallic telephone and similar circuits can also be effected by similar means.

In applying the device in such cases, it had been found that electrodes of carbon suitably prepared and properly separated by a washer of mica, afford specially satisfactory results, making it easy to adjust for very low potentials, while reliability is not seriously jeopardized by the use of magneto call currents, as on telephone lines. With such a construction an ordinary discharge forms a momentary arc of low resistance across the space, opens the circuit instantly by melting the fusible strip or actuating the electro-magnetic device, and is ready for a second service as soon as the circuit is restored.

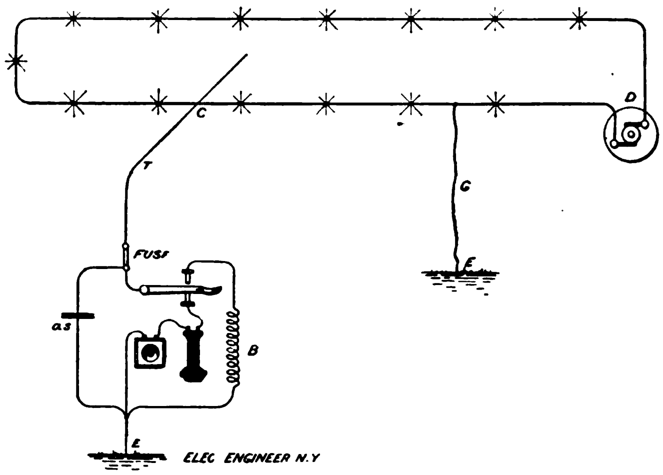


Fig. 3.—The Jenks Air Space Cutout.

It should be remembered that the general adoption of circuits without ground connections for many widespread uses is foreshadowed by the results of years of fire-alarm telegraph work, and by the recent experience of the telephone people in long distance service and comprehensive city switchboards and cables, and that the basis upon which safety (from shocks and fires) in the use of such circuits could be secured was pointed out by Prof. Elihu Thomson in one of the most important papers read before the National Electric Light Association at Kansas City in February last. With these facts in view it will be seen that devices like the one to which allusion has been made are worthy of the most careful consideration by all those personally responsible for the safety of modern electrical conveniences, and also in a very important sense by those who use them with only a general and superficial knowledge of the proper conditions of their operation.

FRANKFORT ELECTRICAL EXHIBITION.

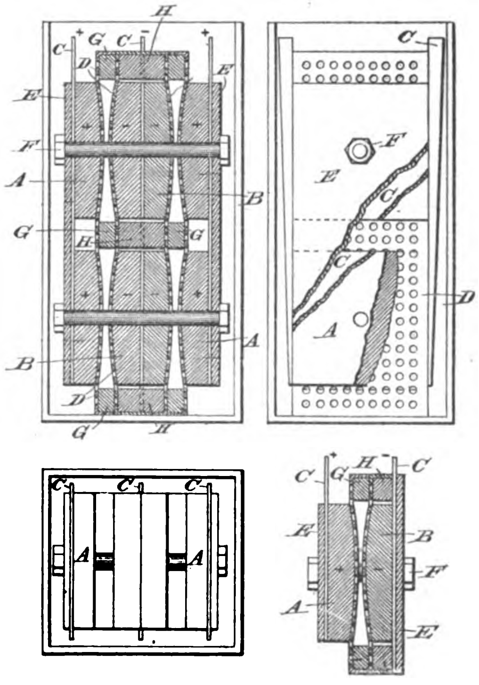
The preparations for the electrical exhibition to be held at Frankfort-on-Main next year are being rapidly pushed forward. Among the numerous applications already received the Swiss Maschinenfabrik "Oerlikon" is noticeable. In connection with electric shipbuilding, the firm of Escher, Wyss and Co., of Zurich, will send a large electric boat, driven by accumulators and capable of carrying 100 persons. This boat, which will be artistically fitted, and furnished, of course, with electric light, will ply on the River Main to serve as aid in the traffic between the interior of the city and the eastern part, where the exhibition is situated. In view of the scope offered for the use of an electric boat service on the lakes in South Germany, Switzerland, and Austria, this part of the proposed exhibition will be regarded with especial interest. We also understand that the Electro-Technical Society of Frankfort have decided to organize an international electrical congress, at the time of the exhibition, at which numerous practical questions will be discussed. At a recent meeting of the organizing committee of the Exhibition it was resolved that, having regard to the expenses and sacrifices which electrical firms and houses taking part in exhibitions of this kind are put to, it is only just that they should be allowed to share in the profits of the undertaking.

HERING'S STORAGE BATTERY.

In a patent recently issued to Mr. Carl Hering, of Philadelphia, the inventor describes a new process of manufacture of the positive and negative plates, which involves several novel features.

For the preparation of the positive plate Mr. Hering employs a dry mixture of powdered peroxide, minium, and lead carbonate (or sulphate) which is mixed with a solution of acetate of lead to a stiff paste. This is then pressed into a mold and punctured in numerous places and dried in an oven. It is then hardened by immersion in sulphuric acid, after which it is mounted and formed.

Secondary battery plates are usually formed in sulphuric acid. Mr. Hering prefers, however, to form them in an alkaline-sulphate solution—such as sodium or or potassium sulphate—as this prevents in a degree the formation of the peculiar white growth around the supports, which attacks the latter when made of lead. After they are formed such growths do not appear. The plates are furthermore strengthened and hardened by a process called "treating." This consists in immersing the plates in a solution of a soluble lead salt or compound—such, for instance, as acetate of lead—then drying them and afterward forming them again with a positive current, as usual. This may be repeated as often as desired, thereby giving the plate any degree of hardness and density. By this process of treatment the soluble salt of lead on drying forms a thin coating on the surfaces of the porous spaces, and on its conversion to peroxide decreases the size of the porous spaces without diminishing their number.



Hering's Storage Battery.

To still further strengthen the plates and render their surface very hard, Mr. Hering electroplates them, after they are formed, with peroxide of lead, by supporting them in a bath of a soluble lead salt—such as the nitrate—together with a suitable cathode, and passing a current through this, making the plates the anode. They then become coated with a layer of deposited peroxide of lead, which is about as hard as highly-tempered steel.

For preparing the negative plates of his battery, Mr. Hering passes a heavy current through an acid bath made of a soluble salt of lead—such, for instance, as the nitrate. The anode in this bath is a slab of lead, and the cathode, straps or wires of lead terminating in points. Arborescent crystals of lead will then be formed at the cathode in large quantities. These crystals are exceedingly thin and possess the property, when fresh, of adhering to each other, or interlocking when pressed together, thus forming a very porous, tenacious mass which is soft, pliable and fibrous, almost resembling a textile material. These crystals are gathered and kept under water until a sufficient quantity is obtained for a plate. They are then put into a mold and sufficient pressure applied to make them adhere to each other. By this means a porous, strongly coherent plate of finely divided lead is obtained which is said to be admirably adapted for the negatives of secondary batteries. The plates prepared in the manner described above are assembled in special manner which is illustrated in the accompanying engravings, the object being to support them so that they can be readily removed and inspected without having to unsolder joints. As will be seen, the blocks of peroxide, A A, are made flat on one side and somewhat cylindrical on the other; B B being the negative plates. The replaceable conductors C C lie against the flat sides of the positive blocks, while the perforated insulating strips D D lie against the rounded sides. The insulating bolts F F which pass through the whole set of plates serve to bind them firmly together, the rubber stops, H H, serving to relieve the negative plates from the excessive pressure due to the bolts F F.

By this construction, the only perishable part, namely, the lead conductors for the peroxide plates, can readily be replaced at small cost, and any defective blocks can readily be renewed, and a block which may break will not necessarily fall out, but will remain in as good working condition as before. The dead-weight is also reduced to a minimum. Ample room is given for expansion in all directions, as well as for unequal expansion of the active material and its conductor, and buckling is thus claimed to be effectually prevented.

A NEW ELECTRIC COAL CUTTER.

The Thomson-Houston Motor Company of Boston, has put in operation an electric coal cutting machine which has attracted attention from mining men throughout the country. The machine is in practical operation near Osceola, Pa. The plant consists of a 7 h. p. steam engine belted direct to a 7 h p. generator. The electric current is conveyed through the mine to the coal cutter, by a wire suspended along the roofs of the chambers. The cutter in this case is nearly a mile from the generating plant. A 5 h. p. motor operates it, and is compactly placed on the same bed plate with the machine. The cutter itself consists of an iron frame 24 inches high, 8 feet 6 inches long, and 36 inches wide. Nine auger shaped drills similar to those now used in mining are placed in the lower part of the frame. Between each drill is a steel cutter-bar which cuts all coal left between the holes drilled by the auger bits. On the under side of each cutter-bar are attached several scrapers which hang loosely and pull all the coal back as fast as it is cut or drilled, keeping it out of the way and making the opening clear. All coal taken out of this cut is coarse and none is wasted.

The height of the cut is four inches. The machine makes two cuts in five minutes, as it is easily handled and needs only to be pushed along the breast by lever bars. The switches and controlling devices are so placed that one man easily operates the cutter. The machine is provided with twin wire cable which is long enough to extend along any ordinary chamber, and does away with the need of permanent wiring except in the headings. A suitable truck is provided for the cutter, upon which it may be carried around the mine with ease. An ingenious device will be provided on future machines, by means of which the motor will pull itself and the cutter off and on the truck as required. The weight of the complete machine is a little over one-half a ton. One strong point in favor of this machine is the readiness with which it accommodates itself to varying hardness of strata. The motors are wound for but 220 volts pressure, so that all danger from high potential currents is done away with. The capacity of the machine is 180 tons of coal per day of ten hours in a four foot vein. Several improvements on the first machine will be embodied in the regular apparatus which is now being manufactured at the Thomson-Houston Motor Company's factories, Lynn, Mass.

ON THE REDUCTION OF THE FRICTION ON THE JOURNAL BEARINGS OF DYNAMOS AND MOTORS.

THAT the loss in efficiency of dynamos and motors, due to the friction on the journal bearings, is considerable, is well understood. But the magnitude of this loss when the machines are under light loads has not been fully appreciated, or if so, has not been given the prominence which it deserves.

On machines under full load the friction on the bearings may be said, in general, to be a very small and often negligible proportion of the total resistance; when, however, the load grows less, this bearing friction becomes a much larger proportion of the total resistance and introduces a loss in efficiency which cannot be considered negligible. This is particularly the case with machines which, while running all the time, are only occasionally under load, as is the case with elevator motors.

In the following are described certain tests made in the laboratory of the Massachusetts Electrical Engineering Co., on an anti-friction roll journal bearing designed especially for dynamo and motor use, and the results of which tests show the importance of the subject.

Efficiency tests were made upon a Weston 15-light arc dynamo, running as a motor, with first, the regular phosphor bronze bearing; second, the anti-friction roll journal bearing.

The armature shaft was of steel. In all, twenty-four tests were made, the object being to make a complete test with each bearing under similar loads. This was accomplished by the arrangement of apparatus shown in Figs. 1 and 2. The motor was belted to a pulley, driving the shaft through an Emerson power scale. On the same shaft was a friction brake, regulated by a tightening screw, and cooled by a tank of water. Great care was taken to keep the belt tension the same; its constancy was assured by weighing, before and after each test, the downward pull of the centre of the belt when raised to a certain height by a special contrivance for the purpose.

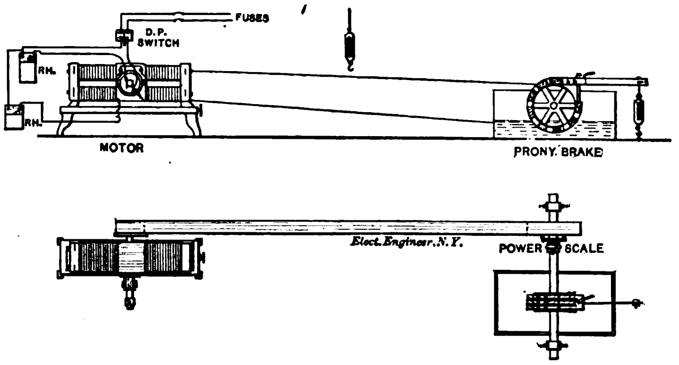


FIG. 1.—MEASURING FRICTION ON DYNAMO BEARINGS.

The electrical measurements were made with a Weston voltmeter and ammeter. Simultaneous readings were taken of the current, electromotive force and speed at the motor, and the weight on the power scale and speed at the countershaft. The Prony brake was used as a check for the power scale.

The commercial efficiency was calculated for each test and a curve drawn for each series, one with the phosphor bronze bearing and the other with the anti-friction bearing. The curves were drawn with the horse-power delivered at the countershaft as abscissæ and the efficiencies as ordinates. From these two curves the increased efficiency at any horse-power output could be found. Fig. 3 is a curve representing the percentage of increased efficiency with the anti-friction bearing.

With the motor running free, 7.9 per cent. more power was consumed with the phosphor bronze bearing than with the anti-friction bearing. With a load of ¼ h. p., the percentage increase in commercial efficiency was 59 per cent. With a load of ½ h. p., the percentage increase in commercial efficiency was 37 per cent. With a load of 5 h. p., the percentage increase in commercial efficiency was 13.5 per cent.

With a load of 7 h. p., the percentage increase in commercial efficiency was 13.3 per cent. With a load of 12 h. p., the percentage increase in commercial efficiency was 4.8 per cent.

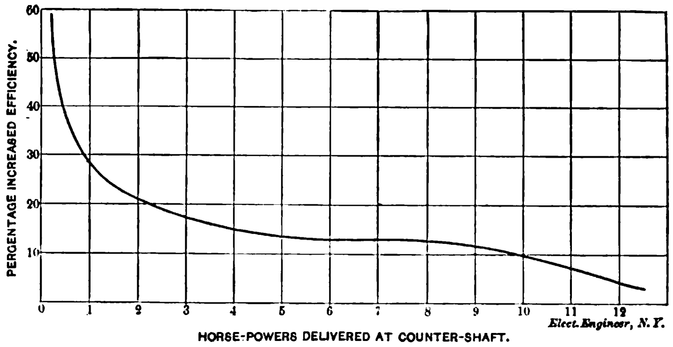


FIG. 2.—CURVE SHOWING INCREASE OF EFFICIENCY WITH INCREASING LOAD.

The greatly increased efficiency on ¼ h. p. load was due to the fact that the journal friction due to the belt tension constituted nearly the whole load. During the test the phosphor bronze bearings were kept as cool as possible. The roll bearings were lubricated when put on to the motor and were not again touched during the test; they did not heat at all.

The results of these tests fully substantiate the assumption that when not under full load the bearing friction is an important factor of the loss. This is all the more important as it has been the practice of nearly all the power companies to install motors of a capacity much above the work required from them, in order that overloading should not occur. In printing office work, for example, the motors are often under half load for the greater part of the time.

ELECTRIC LAUNCHES AT THE EDINBURGH EXHIBITION.

PROPULSION by electricity is effectually demonstrated at the Edinburgh exhibition. The site favored this, as it is skirted by the Union canal, and four launches are running on the canal. These were designed by Messrs. Morton & Williamson, Glasgow, and built by Messrs. T. B. Seath & Co., Rutherglen. The dimensions are 40 feet long, 6 feet 6 inches beam, and the draught of water is 2 feet 1 inch. They each carry forty passengers. The electrical equipment has been supplied by Messrs. M. Immisch & Co., London, and is similar to that used on the Thames launches. The charging plant consists of a 25 horse-power engine and an Immisch dynamo, and the switch arrangement is suitable for charging all the four launches at the same time. The recharging is done during the night and the launch can run ten to twelve hours. The motors are capable of an output of about 3½ brake horse-power, working up to 800 revolutions per minute, and the speed with the maximum load on board is six miles an hour. The propellers are coupled direct to the motor shaft. A ball-bearing thrust block is attached to the motor's bed, and is constructed in combination with the plain bearing of the motor. This is the invention of the Messrs. Immisch, and has been patented by them.

ON THE PERMEABILITY OF IRON AT RIGHT ANGLES TO THE DIRECTION OF MAGNETISATION.—I.

BY A. E. KENNELLY.

Weber's theory of magnetization in the modified form suggested by Clerk-Maxwell is that which appears to meet with the most general acceptance, and it is a notable feature of this theory that it considers the restituting forces acting on the molecule to be a function only of their displacement angle, and to be independent of any mutual reactions between the molecules themselves during magnetisation, or of the influence which combination in polarity might exert upon the equilibrium of their intermolecular forces.

The intimate relations which have been found by so many observers to exist between the mechanical and magnetic conditions of iron in the mass, such for instance, as its alteration in dimensions by magnetisation, the change of its magnetic properties under mechanical stress, the sounds emitted by iron bars under electromagnetic impulses, and the variations in the permeability of iron under varying temperatures,—all suggest the *a priori* probability that the orientation of the molecules supposed to take place during magnetisation, would call into play molecular reactionary forces of a mechanical or magnetic nature, whose effect upon the process would not be negligible, especially in advanced stages. It might be expected, in fact, that these molecular reactions would impede the progress of magnetisation to an extent increasing as that process was continued towards the maximum limit.

Among the wide variations in magnetic behavior exhibited by different specimens of iron differing sensibly in constitution, and the consequent latitude that a theory including all of them must possess, it would be difficult to detect the influence of any such reactions by direct calculation or comparison; but their effect would probably be to increase the apparent relative permeability of iron at right angles to the direction of magnetisation. That is to say, feeble magnetic forces brought to bear upon strongly magnetised iron would probably produce a greater magnetic displacement at right angles to the existing magnetisation than when coincident with it in direction, owing to the expected absence of reactionary forces in the former line.

TABLE I.

Material of Ring.	Internal diameter cms.	External diameter cms.	Depth of ring cms.	Mean diameter cms.	Cross sectional area sq. cms.	Volume by form in cub. cms.	Weight in air, grammes.	Weight in water, grammes at 14° C.	Volume by weight cub. cms.	Specific gravity.
Wood.....	5.30	7.42	1.13	6.36	1.198	23.94	10.704			
Wr'ght ir'n	5.22	7.42	1.12	6.32	1.232	24.465	188.92	164.2	24.72	7.64
Cast iron..	5.22	7.42	1.12	6.32	1.232	24.465	172.27	148.05	24.22	7.11
Tool steel..	5.22	7.42	1.12	6.32	1.232	24.465	191.31	166.87	24.45	7.83

The experiments about to be described, were made with the object of detecting any such difference of permeability if it existed. The results may be considered to have rendered a difference distinctly discernible, in the case of one sample of wrought iron, but with the specimens of cast iron and steel also tested, the conclusions are doubtful; for, although the values obtained for their permeability are certainly greater than theory would warrant, they are not much more divergent than those obtained by the same method for their permeability in the direction of magnetisation itself.

While the success of the investigation has thus been only partial, the interest which attaches to the subject will, perhaps, be sufficient excuse for its complete presentation in condensed and tabular form.

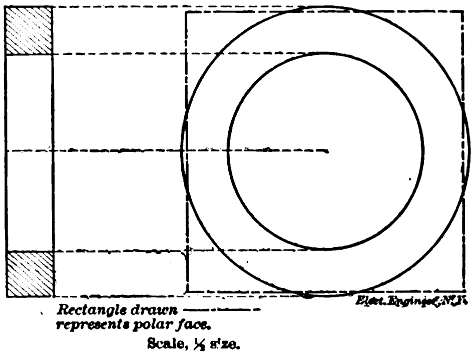
The first experiments were made with a hollow cube of cast iron, 6 cms. in length of edge. Two opposite sides of this box were wound with narrow coils of insulated copper wire passed in and out through slits suitably cut. By placing the box between the poles of a powerful electromagnet, the magnetic flux could be made to pass through one pair of coils and parallel to another pair. The electromagnet was gradually excited, and the induction through the sides of the box measured by a ballistic galvanometer; while the inductance of the coils across the flux was compared with that of the coils wound parallel to the flux by means of the secohmeter.

The measurements, several times repeated, all agreed in showing that the coils across the flux were most reduced in inductance as the flux itself increased; that is to say, the apparent permeability of the iron across the flux was the greater, the ratio being in fact about 2.5 to 1 at an induction of 11,000 C. G. S. lines per sq. cm. through the sides of the cube.

TABLE II.

Ring.	Mean resistance of solenoid and leads observed and corrected for temperature. Legal ohms.	Mean capacity inserted for balance with secohmeter. Microfarads.	Mean induction of coil. Kilometres.	Probable error of mean result. Kilometres.	Number of tests.	Percentage of probable error on inductance.	Ratio of bridge.	Temp. of bridge coils. Bridge correct at 19° C.
Wood....	2.27	0.041	0.9285	±0.0005	5	0.05%	1,000:10	27.3'C.
Wr'g't ir'n	2.28	0.734	167.5	±4.52	5	2.7%	10,000:100	"
Cast iron..	2.32	0.230	53.4	±0.7	5	1.3%	" "	"
Tool steel.	2.32	0.273	63.26	±1.7	5	2.6%	" "	"

On closer examination, however, a serious source of error became evident that ought to have been foreseen at the first. The lines of force issuing from the coil parallel to the flux could not be confined to paths intersecting the flux at right angles, and the many stray lines round the ends of the coils along the main path of induction produced an error in the measurements too great to be neglected, and too complex to calculate. The cube was, therefore, abandoned in favor of a more unexceptionable arrangement.



FIGS. 1 AND 2.

Four rings were then prepared, as shown in plan and diametral section in Figs. 1 and 2, of practically equal dimensions and rectangular cross-section, one of wood, the second of ordinary wrought iron, and the other two of cast iron and tool steel, respectively. The particulars of their dimensions are given in Table 1.

These rings were each wound with copper wire 0.036 cm. diameter, silk covered to 0.046 cm. in one complete layer of 289 turns, over oil paper. The weight of this layer was 18.5 grammes, and its resistance 2.2 ohms at 22° C.

The inductance of these solenoids was then measured with the following results, Table II, using a bridge, standard subdivided condenser, and secohmeter for reversals by a modification of Clerk-Maxwell's method.

The somewhat low degree of precision in these measurements indicated by the probable error is due to the difficulty so often met with in measuring the inductance of coils surrounding soft iron, with feeble testing currents. The precision increased however as the inductance lowered. The strength of the testing current in the above series was 29 milliamperes, at the maximum steady value, from which H would be 0.53 in each coil.

The rings were then placed in succession symmetrically between the poles of the above-mentioned electro-magnet, so that the magnetic axis apparently coincided with the axis of the ring. The polar faces were planes 7.3 cms. × 7.4 cms., and were kept apart 1.6 cm. by corner wooden wedges so as not to compress the ring. With the magnet unexcited, the inductance of the rings was found not to be sensibly altered by the presence of the iron poles, but on powerfully exciting the magnet, that of the three iron rings fell to quite a small percentage of its normal value, viz.: Wrought iron, to 20 per cent.; cast iron, to 13.8 per cent, and tool steel to 25.4 per cent.; the original values being restored on the cessation of the exciting current in the coils of the electro-magnet. The inductance of the wooden ring was quite unaffected, as might be supposed.

Steps were next taken to measure and control the amount of this magnetic flux across the ring, observing the inductance at each step. For this purpose, five turns of fine, insulated copper wire were wound on the external periphery of each ring, and five similar turns applied to the inner periphery by winding them on a closely fitted cork. The induction through these two windings at each stage of the magnetization was measured in the usual way by electro-magnetic reversal and ballistic galvanometer.

The difference between these inductions (slightly corrected for winding space occupied by the solenoidal coil),

TABLE III.

Transverse Magnetisation of Wrought Iron Ring, Between Poles of Electro-Magnet.

Source of E. M. F.	Temp. of cells ° C.	E. M. F. at observed temperature.	Capacity of condenser.	Q × 10⁷	Number of throws.	Mean throw.	Probable error of mean throw.	Values of one division in absolute measure.
2 Clark cells in series.	25.5° C.	Legal volts. 2.858	0.409 mfds.	1.167	8	Divs. 101.9	Divs. ± 0.17	1.145×10^{-9}

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
No. of observations.	Current (amperes) exciting electro-magnet.	Mean throw of galvanometer from solenoid.	Resistance of galvanometer circuit. Average 𝔅 round ring.	Mean throw of galvanometer from interior coil. Probable error of mean.	Corrected φ; or induction corrected for winding space.	Mean throw of galvanometer from exterior coil. Probable error of mean.	Resistance of galvanometer at	Corrected total induction, Φ, allowing for winding space.	$\Phi - \varphi$ or tota induction through iron.	𝔅, or transverse induction density through ring.	Ratio of bridge.	Resistance of solenoid and lead, observed.	Capacity for balance with secohmeter.	Inductance of solenoid in kilometers.
												Ohms.	Micros.	
1	0.089	3	25	0.	0	16.5 ± 0.4	5250	9,920	9,920	450	$\frac{10000}{100}$ Temp. Bridge 27.5° C.	4.559	0.400	182.4
2	0.1845	3	25	2.6 ± 0.9	1,750	41.7 ± 0.5	"	24,710	22,960	1,050		4.554	0.400	182.2
3	0.44	7	59	6.3 ± 0.5	4,240	104.2 ± 0.5	"	61,750	57,510	2,630		4.557	0.400	182.3
4	1.08	5	5250 ω 42	26.8 ± 0.1	18,050	45.0 ± 0.	30,250	152,170	134,120	6,140		4.560	0.300	136.8
5	1.195	57	480	66.5 ± 2.2	44,780	75.5 ± 0.	"	252,250	207,470	9,500		4.568	0.080	36.5
6	3.51	83	700	76.3 ± 0.3	51,380	88.5 ± 0.2	"	295,780	244,400	11,190		4.568	0.075	34.3
7	5.35	90	760	81.7 ± 0.5	55,030	97.3 ± 0.3	"	325,630	270,600	12,390		4.573	0.075	34.3
8	11.59	86	730	93. ± 0.8	62,640	109. ± 0.4	"	364,560	301,920	13,820		4.573	0.073	32.9
9	18.6	78	660	93. ± 2.4	62,640	115. ± 0.	"	385,460	322,820	14,780		4.620	0.071	32.8
10	0.	..	...	....	......	....	......	....	....	......		4.620	0.480	221.8

Column IV. gives 𝔅 determined from the equation $\mathfrak{B} = \frac{5.250 \times 10^{12} \times 1.145 \times 10^{-9}}{2 \times 289 \times 1.23} \times$ mean throw.

Column VI. gives φ " " $\varphi = \frac{5.25 \times 10^{12} \times 1.145 \times 10^{-9} \times 1.121}{2 \times 5} \times$ mean throw.

1.12 being the ratio correction for winding space.

Column IX. gives Φ " " $\Phi = \left(\frac{5.25 \times 10^{12} \times 1.145 \times 10^{-9}}{2 \times 5} \times \text{mean throw} \right) - \frac{4.42\,\varphi}{21.4}$

Column XI. gives 𝔅 " " $\mathfrak{B} = \frac{\Phi - \varphi}{21.85}$

The constant 1.145 × 10^{-9} is the absolute quantity per division of throw.
289 is the number of turns in solenoid.
5 is the " " in external and internal coils.
1.12 is the correction factor for internal winding space.
4.42 is the area occupied by winding between iron and external coil.
28.4 is the internal area of iron ring.
21.85 is the plane area of iron in ring.

TABLE IV.

Transverse Magnetisation of Cast Iron Ring, between Poles of Electro-Magnet.

Source of E. M. F.	E. M. F. at observed temperature 23° C.	Capacity of Condenser charged.	Quantity discharged through galvanometer.	Number of throws observed.	Mean throw.	Probable error of mean throw.	Quantity represented by one division.	Time of observation.	Mean quantity per division of throw.	
2 Clark cells in series.	2.858 legal volts.	0.409 ϕ	1.169×10^{-9}	5	102.5	± 0.1	$1\ 1405\times10^{-9}$	before test.	1.141×10^{-9}	
	2.858 " "	"	"	2	102.5	± 0.4	1.1405×10^{-9}	after test.		

I. No. of observation.	II. Current exciting electro-magnet in amperes.	III. Mean throw of galvanometer from solenoid.	IV. Resistance of galvanometer circuit.	Average $\mathfrak{B}$ round ring.	V. Mean throw of galvanometer from interior coil. Probable error of mean.	VI. Corrected ϕ or interior induction corrected for winding space.	VII. Mean throw of galvanometer from exterior coil. Probable error of mean.	VIII. Resistance of galvanometer circuit.	IX. Corrected total induction Φ, allowing for winding space.	X. $\Phi-\phi$ or total induction through iron.	XI. $\mathfrak{B}$, or mean transverse induction density through ring.	XII. Ratio of bridge.	XIII. Resistance of solenoid and leads, observed.	XIV. Capacity inserted for balance with secohmeter.	XV. Inductance of solenoid in kilometres.
1	0.	—		—	—	—	—	5,250ω	—	—	—	$\frac{10000}{100}$	4.575	0.101	46.2
2	0.088	5	5250 ω	42	2. ± 0	1,340	16. ±0·	"	9,300	7,960	365		4.639	0.099	45.9
3	0.112	1		8	3. ± 0	2,010	17.5±0.4	"	10,060	8,050	369		4.655	0.098	45.6
4	0.162	2		17	4.5± 0	3,020	36. ±0.8	"	20,940	17,920	820		4.651	0.097	45.1
5	0.30	5		42	9.5±0.8	6,380	73.5±1·2	"	42,700	36,330	1,660		4.668	0.093	43.4
6	0.459	10		84	15.5±0.8	10,400	119. ±1·7	"	69,080	58,680	2,690		4.666	0.091	42.5
7	1.11	13		109	34	22,810	44.3±0·5	30,250	148,190	125,380	5,740		4.690	0.070	32.8
8	2.63	32		270	58. ±0.8	38,810	77.7±0·3	"	260,180	221,370	10,130		4.707	0.040	18.8
9	4.93	45		380	73	49,000	92.5±0.4	"	309,060	260,080	11,940		4.707	0.038	17.9
10	20.7	57		479	94	62,890	109.5±0·4	"	364,910	302,020	13,830		4.716	0.027	12.7
11	0.	—		—	—	—	—	—	—	—	—		4.713	0.095	44.8

TABLE V.

Transverse Magnetisation of Tool Steel Ring, between Poles of Electro-Magnet.

Source of E. M. F.	E. M. F. at observed temperature 22° C. (Legal volts.)	Capacity of Condenser charged.	Quantity discharged through galvr.	Number of throws observed.	Mean throw.	Probable error of mean throw.	Quantity per division of throw.	
1 Clark cell.	1.430.	1.000.	1.48×10^{-7}	7.	123.6	± 0.3	1.157×10^{-9}.	

I. Number of observation.	II. Current exciting electro-magnet in amperes.	III. Mean throw of galvanometer from solenoid.	IV. Resistance of galvanometer circuit for solenoid and interior coil.	Mean $\mathfrak{B}$ round ring.	V. Mean throw of galvanometer from interior coil. Probable error of mean.	VI. Corrected ϕ or interior induction corrected for winding space.	VII. Mean throw of galvanometer from exterior coil. Probable error of mean.	VIII. Resistance of galvanometer circuit.	IX. Corrected total induction Φ allowing for winding space.	X. $\Phi-\phi$ or total induction through iron.	XI. $\mathfrak{B}$, or mean transverse induction density through ring.	XII. Ratio of bridge.	XIII. Resistance of solenoid and leads, observed.	XIV. Capacity inserted for balance with secohmeter.	XV. Inductance of solenoid in kilometres.
1	0.	—		—	—	—	—	5,250	—	—	—	$\frac{10000}{100}$	4.490	0.114	51.2
2	0.086	0	5250	0	0	—	15.5±0.7	—	9,410	9,410	430		4.490	0.113	50.7
3	0.115	7.5		64	6.7±0.3	4,560	48.4±0.3	—	27,730	23,170	1,060		4.505	0.118	53.2
4	0.445	18		150	16.2±0.7	10,890	135.8±0.6	—	78,470	67,580	3,100		4.505	0.108	48.7
5	0.985	73		620	39.7±1.0	27,020	333. ±0.4	—	192,410	165,390	7.570		4.495	missed	—
6	1.854	7	30.250	340	18. ±0.	70,560	93.0±0.	30,250	299,670	229,210	10,500		4.463	0.073	32.6
7	3.38	7		340	21.8±1.0	85,480	114.5±0.4	—	369,500	284,020	13,000		4.449	0.055	24.5
8	4.80	7		340	23. ±0.	90,190	121.5±0.4	—	392,280	302,090	13,830		4.432	0.050	22.2
9	9.65	0		0	27. ±0.8	105,900	138. ±0.	—	444,350	338,450	15,500		4.432	0.031	13.7
10	0.	—		—	—	—	—	—	—	—	—		4.603	0.110	50.6

being the total flux through the ring normal to its plane, the mean value of the induction per sq. cm. was immediately determined. The induction in the solenoid was similarly observed to make sure that no great error was involved by any want of accuracy in the alignment of the ring axis between the poles, this induction being of course with perfect alignment equal to that through one turn round the external periphery.

The results obtained in this way with each iron ring are given in tables III., IV. and V.

The exterior and interior turns were next removed, and a primary solenoidal winding of cotton-covered wire laid on each ring over the original layer now used as a secondary. This done, the rings were magnetized in the usual circular manner by measured currents through the primary coil, while the corresponding induction through, and inductance of the secondary layer, were observed at each step. This determined the inductance of the coil corresponding to each value of the magnetizing force and circular induction per sq. cm. The results with each ring are given in Table VI.

THE ELECTRICAL "AGEING" OF ALCOHOL.

After the crude material has been obtained, there are two stages in the process of preparing alcohol, namely, the rectification and the ageing. The method usually adopted for the latter purpose is to allow the spirit to remain several years in badly-corked barrels. This naturally involves the storage of large quantities of spirit, and to overcome this disadvantage M. Teillard has adopted the Broyer-Petit electro-chemical method at his distillery at Tournus. The principle of this process is to hasten the oxidation of the alcohol by exposing it to the action of ozone. To prepare the ozone two spirals of aluminium are arranged, one outside and one inside a perforated glass tube 1 cm. in diameter and 45 cm. long; around this tube is another one. The ends of the two spirals pass through the outer tube, and are connected to the terminals of an induction coil. Oxygen is sent through the inner tube, and is exposed to the influence of silent discharge between the two spirals. Great care is required in this operation. No spark must occur, and the temperature of the apparatus must not exceed 15° to 20° C., or the ozone will be destroyed. In actual practice the oxygen is passed through three such tubes in succession the induction coils being worked by a dynamo giving 3 volts and 6 amperes. By this means 10 cubic ms. (353 cubic feet) of oxygen is ozonized per hour. In addition to the dynamo, engine, and boiler, the complete installation comprises an oxygen gasometer of 20 cubic ms. capacity, six spirit vats, an oxygen pump, and an alcohol pump. All taps must be of wood, all tubes of glass, all plugs of cork, and the interior of the vats completely stripped of metal, owing to the energetic action of the ozone. In carrying out the process six vats are first filled with spirit. Oxygen is then passed from the gasometer over chloride of calcium to dry it, and is then passed through the ozonizers to a flask with three tubulatures, and thence through the six vats in succession to the condenser, where any vapor of alcohol taken up is deposited. The gas is then regenerated and used afresh. The volume of ozone required is about six times the volume of the alcohol treated, and the time required varies from five to six hours. Alcohol so treated is then stored in barrels, and after five or six months is ready for use.

Table VI.

Magnetisation of Rings. Solenoidal. Three primaries in series.

Source of E. M. F.		E. M. F. at observed temperature 22.5° C.		Capacity of condenser charged.		Quantity discharged through galvanometer.		Number of throws observed.		Mean throw.		Probable error of mean throw.		Quantity per division of throw.
1 Clark cell.		Legal volts 2.859.		0.409 φ.		1.1695×10^{-7}.		8.		101.6.		± 0.2		1.151×10^{-9}.
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
Number of observation.	Ring tested.	Current in primaries —amperes.	Magnetic force, H.	Mean throw from solenoid secondary. Probable error of mean.	Resistance in galvanometer circuit.	Induction through iron, φ.	Induction density through iron. 𝔅.	μ or $\frac{𝔅}{H}$	k or $\frac{\mu-1}{4\pi}$	Ratio of bridge.	Resistance of solenoid and leads, observed.	Capacity inserted for balance with secohmeter.	Inductance, kilometres.	
1	Wrought Iron.	0	—	—						$\frac{10000}{100}$	5.805	0.350	203.	
2		0.088	1.07	103.6±0.8	5,250	1,080	880	825	65		5.807	0.350	203.	
3		0.223	2.70	90.5±0.7	30,250	5,460	4,430	1,640	130		5.824	0.175	101.9	
4		0.600	7.13	177.3±0.2	"	10,680	8,670	1,216	97		5.834	0.140	81.7	
5		1.11	13.4	66.1±0.5	105,250	13,850	11,240	840	67		5.844	0.090	52.6	
6		2.73	33.0	84.3±0.3	"	17,670	14,340	435	35		5.854	0.037	21.7	
7		4.31	52.2	90.5±0.4	"	18,970	15,400	295	83		5.980	0.025	14.8	
8		10.03	121.4	98.5±0.4	"	20,650	16,760	138	11		6.023	0.015	9.0	
1	Cast Iron.	0	0							$\frac{10000}{100}$	5.877	0.056	32.8	
2		0.088	1.06	6.8±0.3	5,250	71	58	54	4.3		5.855	0.056	32.8	
3		0.223	2.69	19.7±0.3	"	226	184	68	5.4		5.883	0.057	33.5	
4		0.600	7.09	114.9±0.4	"	1,200	976	138	10.9		5.838	missed	—	
5		1.11	13.4	72.1±0.3	30,250	4,340	3,530	264	20.9		5.894	0.059	34.8	
6		2.73	32.9	72.0±0.4	55,250	7,930	6,430	196	15.5		5.916	0.033	19.7	
7		4.31	51.9	45.2±0.1	105,250	9,480	7,690	148	11.7		6.033	0.027	16.3	
8		10.03	120.8	58.5±0.4	"	12,260	9,950	82	6.5		6.300	0.017	10.7	
1	Tool Steel.	0	0							$\frac{10000}{100}$	5.858	0.059	34.6	
2		0.088	1.21	7.3±0.3	5,250	76	62	51	4.		5.867	0.060	35.2	
3		0.223	3.07	23.3±0.3	"	244	198	64	5.1		5.877	0.065	38.2	
4		0.60	8.12	117.5±0.4	"	1,230	998	130	10.		5.838	0.061	35.6	
5		1.11	15.3	115.8±0.6	30,250	6,980	5,660	370	29.		5.901	0.078	48.1	
6		2.73	37.6	121.7±0.9	55,250	13,390	10,880	290	23.		5.929	0.035	20.7	
7		4.31	59.4	73.[illegible]±0	105,250	15,300	12,420	209	17.		6.040	0.026	15.7	
8		10.03	138.0	88.[illegible]±0.8	"	18,440	14,970	109	8.5		6.410	0.014	9.0	

ELECTRICITY IN PAPER MAKING.

For some time cellulose has been used in the manufacture of paper, but its extended adoption has been retarded by its high price. Dr. Kellner, Director of an Austrian cellulose factory, has, says the *Elektrotechniches Echo*, succeeded in reducing the cost by the following process: The shredded wool is put into lead-lined boilers with a 5 per cent. solution of common salt, which is electrolyzed for three and a half hours. The nascent chlorine bleaches the wool fibre to a snow-white silky substance. The operation is conducted at a temperature of 126 deg. to 128 deg. Centrigrade. The process is expected to have an important effect on the trade, as the paper made from cellulose is of particularly fine texture.

ELECTRICAL ENGINEERS.

CHARLES WILLIAMS, JR.

The subject of this sketch is unquestionably one of the pioneers of the telephone. Without him it is doubtful if even Prof. Alexander Graham Bell would have perfected his telephone. Without him it is almost certain the American Bell Telephone Company, now so rich and powerful, would have failed, or at least been obliged to struggle on much longer against adverse opinion and financial difficulties.

Mr. Williams began his electrical career in the "forties," soon after he entered into partnership with a Mr. Hinds, who did business as Hinds & Williams, dealers in and makers of electrical apparatus and supplies. This continued until Mr. Hinds retired, leaving the business to Mr. Williams. Soon afterwards, Prof. Bell met him and together they prosecuted experiments which resulted in a practical telephone line between his factory on Court street, Boston, and his house at Somerville, Mass. The first magneto call-bells and switch board devices were made at this place—crude and imperfect affairs—but they gave promise of usefulness and developed into satisfactory apparatus later. This factory supplied all the material for a long time, required by the National Bell Telephone Company, and Mr. Williams was for years the sole licensed manufacturer of this company. It was through the ownership of this company's shares, then looked upon with disfavor and suspicion, but probably the only available asset of the struggling company and taken with reluctance, that Mr. Williams acquired the bulk of his wealth. When value came to them, it came quickly and bountifully and a doubtful asset became a very remunerative one.

It was in April of 1877 that this first private line was built and used; and in May of that year the first public switchboard—made to connect a very few stations—was set up and operated at the store of E. T. Holmes, No. 342 Washington street, Boston.

C. Williams Jr.

Charles Williams, Jr.

It is not necessary to follow the growth and rapid development of the telephone system, but all who are familiar with the facts will readily concede the instrumentality of Mr. Williams in its successive stages. The "Williams" magneto call-bell and "Williams" switchboard remain to-day standards for excellence and utility.

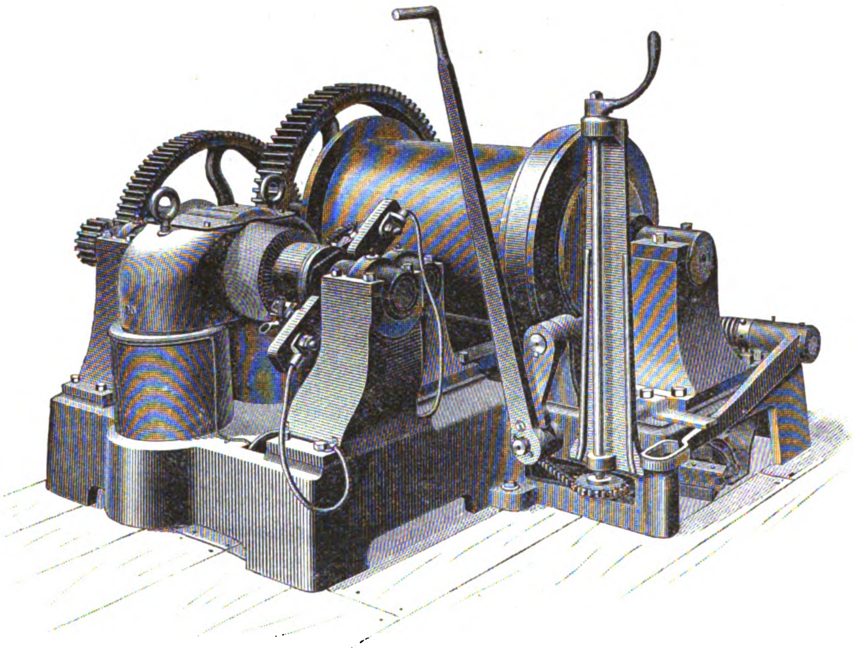
Mr. Williams retired from the field as licensed manufacturer for the American Bell Telephone Company in 1886, when it became necessary to start an independent and extensive workshop to supply the increased business of the country. This was done through the medium of the now celebrated Western Electric Company, whose factories in Chicago and New York are well known to every electrician and electrical engineer in the country. Mr. Williams remains to-day one of the largest individual stockholders in the Western Electric Co. He is also president of the Tropical American Telephone Co. He does not, however, deem it necessary to bestow close personal attention on his affairs, but has for some time past enjoyed a well earned leisure with his family in Berlin.

THE DAVIS ELEVATED ELECTRIC RAILWAY.

Mr. A. Davis, formerly of the North Shore Railway, has completed his plans for an elevated electric railway for Montreal, and has secured patents for the inventions which are the distinguishing features of the system. Mr. Davis in drawing up his plans has been guided by the conviction that it is necessary that any elevated road built in Montreal must be cheap and not injurious to the property along the route. He thinks that he has succeeded in meeting these requirements, as his system does not interfere with the light, is smokeless and noiseless and will cause no dust. The track is elevated on a series of single posts, 60 feet apart, and the structure altogether is said to be so light and ornamental that there can be no objection to it on the ground of unsightliness, urged so strongly against the elevated railroads in American cities. The posts are constructed in four sections, bolted together, so that a flaw can occur in one of the sections without endangering the whole structure. Single girders, resting on these pillars, and sunk six inches into their heads, carry the rails. Distinctive features of the system are the provision for supplying the motive power to the cars, and an extra safety appliance. The conductor conveying the current from the station runs along the top chord of the girder. The cross-ties, instead of being fastened to the top of the girder, are passed through the bottom of that piece of lattice work, so that the upper portion of the girder projects upward through the track bed to within an inch of the bottom of the cars. The upper chord of the girder, which carries the conductor, ends in a "T" iron. The motor is fastened under the center of the car, and the electricity is conveyed to it by two wheels, which grip the conductor and can be regulated from the interior of the car at will. The wheels are completely free from brake friction, as the brake system consists of a pair of shoes adjusted so as to grip the top chord of the girder on either side. The safety of the car is arranged by two slides passing freely under the top piece of the upper chord of the girder, and in case a wheel should break, the bottom of the car, having only one inch to fall before resting on the girder, would be firmly held in position by the safety guards. The motor can be made to work direct by steam, cable, or by electricity, which is the cheapest method. The plans provide for handsome cars and stations, the appearance of everything having been carefully studied. Mr. Davis estimates the cost at under $25,000 a mile all equipped, and he says he can get all the money necessary to carry out the undertaking if he can only secure a substantial contract. It will be interesting to see whether any work on his system is attempted. The time is ripe for it.

THOMSON-HOUSTON ELECTRIC HOISTS.

THE general applicability of the electric motor for power purposes compared with the steam engine is not better exhibited than in an installation which has just been put to work on one of the docks of Henderson Bros., agents of the Anchor Line S. S. Co., in Brooklyn. The use of the steam engine on docks where large quantities of cotton are handled, being considered extremely dangerous on account of danger from fire, the application of an electric hoist was therefore the only available plan, and it has been very neatly carried out by the Thomson-Houston Motor Company, who have supplied the apparatus shown in the accompanying engraving, but mounted upon wheels so that it can be easily transported from one part of the dock to the other and then connected to the leads which extend around the dock. The motor is of the same class as that employed for stationary work, except that it is series wound, the speed being regulated by a rheostat placed underneath a drum and controlled by a slight motion of the lever held in the left hand of the operator, which is so adjusted that the heaviest loads can be raised, lowered, or held without the use of the brake. The latter consists of an iron strip lined with wood and encircling the drum for more than three-fourths of the circumference. It can be applied by the simple pressure of the pinions. The gears are made of gun metal and run practically without noise, while the use of carbon brushes reduces the wear on the commutator to a minimum. The test which took place last week in the presence of a large number of gentlemen interested in shipping, was highly satisfactory, and we shall without doubt see many more applications of this kind in the near future. The work of installation was done under charge of Mr. H. C. Radford, of this city, who is the Thomson-Houston Motor Co.'s representative in N. Y. State. The next hoist which is to go in is to be slightly different in form, and is to have a higher speed. Mr. Radford devotes most of his time to this class of work, and firmly believes that the entire lading and discharging of vessels as well as the transportation of goods from the docks into the stores will eventually be done by means of electricity, and, from the success of his recent experience, we are inclined to agree with him on this subject.



THOMSON-HOUSTON ELECTRIC HOIST.

ELECTRIC TANNING.[1]

ON Wednesday, May 14th, the British Tanning Company, Limited, who own the British patents of MM. Worms and Balé, issued invitations to the members and press of the tanning, electrical, and allied trades, to inspect their works at Rothsay street, Bermondsey, and see the process of rapid electric tanning in operation. A considerable party of visitors, numbering nearly a hundred, were present, including several well-known tanners. They were first shown a drum containing tan liquor of the required strength, into which a pack of Australian salted hides, unhaired and cleaned in the ordinary way, were put. The drums employed are 11 feet 6 inches in diameter by 8 feet wide, and contain an electrode running round the interior of one end or head, from which the current passes through the liquor to a similar conductor on the other head.

The drum was set in motion, and a current of 10 amperes passed through the liquor. The action of the current which is applied is partly *to promote diffusion* and partly *to electrolyze the liquor*; both these effects, aided by the rotation of the drum, are no doubt the explanation of the remarkable saving of time effected by this process, it being possible thus to tan skins and hides in from 24 to 144 hours, against four to fifteen months by the old process of steeping in pits. A drum was opened which had been running for a little over five days, sections of the hides (salted Australian) were cut and examined by tanners present, and found to be thoroughly tanned. The visitors then inspected the drying sheds and shops above, where leather was seen in all stages, rolled for sole leather, curried, etc., also some hides prepared for machine belting. According to some tests shown us by Mr. Conrad Falkenstein, manager at Rothsay street, the tensile strength before breaking, taking the average from a number of samples, was equivalent to 4,305 lbs. per square inch for the electrically tanned leather, against 3,570 to 3,800 for leather tanned by the ordinary process. The leather is now being sold in the market, and is steadily taking its place in every branch of the trade. The company has an exhibit at the Edinburgh Exhibition, where samples of rough and dressed leather tanned by this process are on view.

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[1] London *Electrical Review*.

AN ELECTRIC ACOUMETER.

With a view of preventing fraud on the part of those who have been drawn for military service, and with whom partial deafness is a very common plea for exemption, Dr. V. Cheval, of Brussels, has brought out a modification of Prof. Hughes' sonometer, which he calls an electric acoumeter. The apparatus consists of three flat coils placed parallel to one another on a graduated rod passing through their axes. The centre coil is the primary and is fixed; the two outer coils are secondaries, and can be slid along the rod. The rod and coils are arranged on a board, on which there are an electrical tuning fork, a microphone, switches, plugs and other accessories. The individual whose hearing is to be tested is placed with his back to the apparatus, and has two telephonic receivers fixed tightly over his ears. Various sounds are then produced; the two outer coils being moved gradually away from the centre one until no noise is heard in the telephone receivers. The distance through which the coils have been moved is a measure of the hearing power of the individual. According to Dr. Cheval's investigations a person gifted with a fine sense of hearing ceases to hear the telephonic vibrations of a tuning fork on the left side when the coil is 435 mm. distant, and on the right side when the coil has been moved through 535 mm. For less sensitive ears the distances are respectively 293 and 401 mm. Deafness sufficiently pronounced to exempt from military service is represented by a distance of 100 mm. These distances, of course, are not absolute, and only refer to the particular apparatus employed in these researches.

THE NEW WENSTROM DYNAMO.

Some years ago Mr. Jonas Wenstrom, a Swedish electrical engineer, brought out a type of dynamo, Fig. 1, in which the construction of the magnetic field as well as the disposition of the armature wires attracted considerable attention. The form of field adopted in this machine was what is now known as the iron-clad type, in which the magnetizing coils are surrounded by iron in all possible directions, in order that the iron core may collect practically all of the exciting force radiating from the coils. Evidently from this arrangement it follows that the exciting power may be less, all other things being equal, because the power is better utilized.

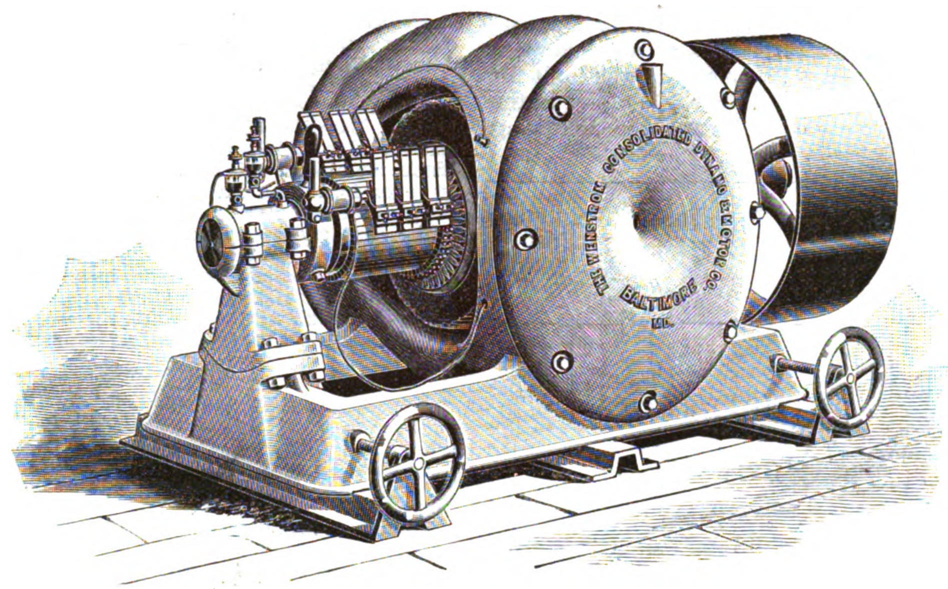
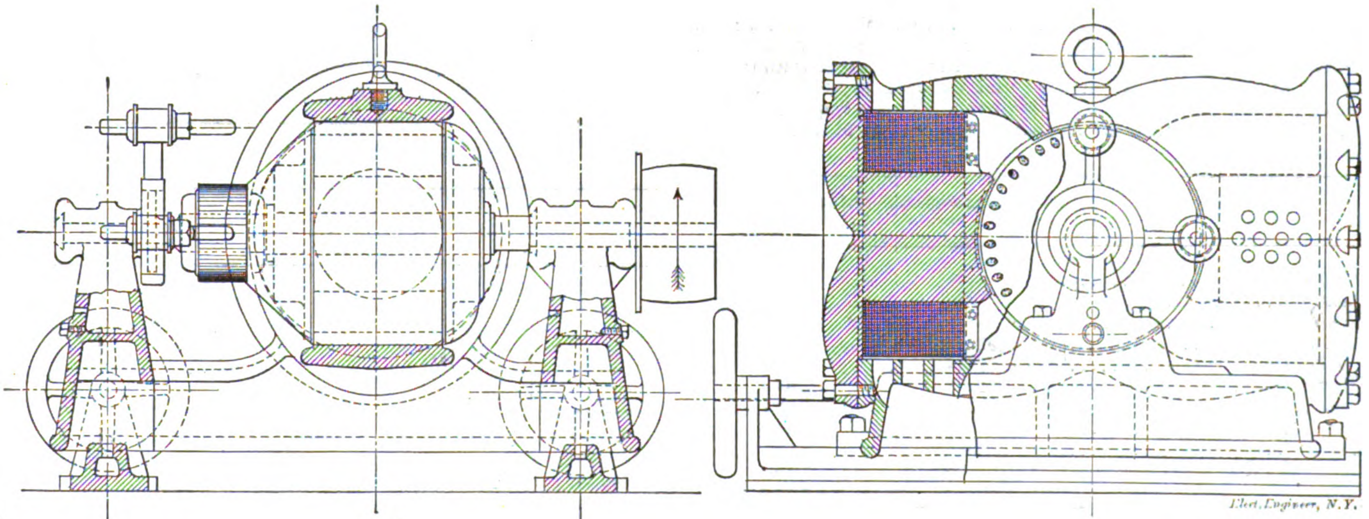

THE WENSTROM CONSOLIDATED DYNAMO & MOTOR CO.
BALTIMORE
MD.

Fig. 1.—The New Wenstrom Dynamo.



Figs. 2 and 3.—New Wenstrom Dynamo.

The machine in its improved form is now built by the Wenstrom Consolidated Dynamo and Motor Co., of Baltimore, Md., and the accompanying engravings, Figs. 2 and 3, show it in transverse and longitudinal section, respectively.

Usually the space between the magnet poles and core of the armature must be sufficient not only for the safe revolving of the armature at a high rate of speed, but also for the conductors, in which the currents are induced. This gap introduces a very high magnetic resistance in the circuit for the magnetic induction. To avoid this, therefore, the conductors are buried in grooves or holes.

The distance between the poles and the core is thus limited to the small gap required for the safe revolving of the armature. The magnetic resistance and the magnetic circuit is by this means reduced in a high degree, and consequently, the magnetizing power necessary for creating the required magnetism in the armature also decreased.

Some time ago a test was made by Dr. Louis Duncan, Dr. G. A. Liebig and Mr. W. F. Hasson, on a 400 ampere 110 volt dynamo of this type. The machine was built for 400 revolutions per minute, and weighed 7,100 lbs.; in the test it was run at 330 revolutions and gave the following results:

Current, amperes.	E. M. F., volts.	Horse-power.	Dynamometer, horse-power.	Loss.	Losses, friction reversals.	C^2 R.	Efficiency.
134.8	114.0	20.6	24.97	4.4	4.4	.17	82.5%
194.1	115.6	30.1	35.3	5.2	4.5	.52	85.2%
371.6	98.3	49.0	54.5	5.5	3.5	1.30	89.9%
400.0	110.0	58.9	64.7	5.8	4.1	1.50	91.0%

We may add that many of these machines are already in satisfactory use in this country.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.[1]

BY WILLIAM HENRY PREECE, F. R. S.

THE effects of the heat developed in conductors when electric currents are transmitted through them have been the subject of constant investigation on my part since 1878. In 1880 I found that the rapidity with which small bare wires acquired higher temperatures and lost them in air was so great that it was possible to reproduce sound and speech by means of the thermo-telephone (*Roy. Soc. Proc.*, No. 204, 1880).

I determined subsequently (*Roy. Soc. Proc.*, No. 231, 1884) the current that raised the temperature of small conductors in air to the fusing point, and proved experimentally that, while bare cylindrical wires of very small diameter did not follow the $d^{\frac{3}{2}}$ law, this law became rigid for all diameters above 1 mm.

Papers *Roy. Soc. Proc.*, November 24, 1887, and March 15, 1888, dealt principally with the fusing points, and the following table, to which I have added silver, gives the fusing constants for all the metals in general use when bare and exposed in still air. The numbers indicate the current in amperes which is required to fuse a cylindrical conductor of a diameter of 1 cm. of the material named.

	Fusing constant. (a).	Fusing temperat're C°.
Copper	2530	1054
Silver[2]	1900	954
Aluminium	1873	650
German silver	1292	1200
Platinum	1277	1775
Platinoid	1173	1300
Iron	777.4	1600
Tin	405.5	226
Lead	340.6	335
Alloy (lead 2 parts, tin 1 part)	325.5	180

I have added the temperature of fusion to each of these metals, and the table means that if we take, for example, a uniform copper wire of 1 cm. diameter, a current of 2530 amperes will raise it to 1054° C., and therefore fuse it; and if we take any similar conductor of copper, but of different diameter (d), the fusing current (C) is

$$C = 2530\, d^{\frac{3}{2}}.$$

The fusing current of any other material is obtained from the equation.

$$C = ad^{\frac{3}{2}}.$$

It seemed natural that these constants, marking such a distinct and well-defined fiducial point, should also enable us to obtain the currents that would raise the wire to any other temperature.

A constant current traversing a cylindrical metallic conductor does work (W) upon that conductor to an amount which is measured per second by the product of the electromotive force (E) at the ends of the conductor and the current (C), or

$$W = E C.$$

This work appears as heat. The temperature of the conductor is raised. When the temperature of the wire becomes constant the expenditure of energy in the wire, and its dissipation by radiation and convection from the surface of the wire, must be equal and constant also. Hence the temperature of the conductor when constant becomes a measure of the work done per second, and therefore a measure of the constant current flowing. The rate of loss of heat per degree per unit area of any surface is its emissivity (e). The value of e depends upon the character of the surface, that is, whether it is polished or rough, clean or dirty, bright or black, metallic or oxidized, painted or coated with some preservative or insulating medium. For the present we will consider an unprotected surface comparable with the surface when at white heat, and we will call that surface *normal*. Let a current be applied to a given conductor, exposed in still air at atmospheric pressure, until it assumes any constant temperature (T), the surrounding objects being at a lower temperature (T_1); then the total heat (W) which will be emitted per second by the whole surface (S) of the wire to the surrounding objects will be

$$W = e\mathrm{S}\,(\mathrm{T}-\mathrm{T}_1).$$

Hence $$EC = e\mathrm{S}\,(\mathrm{T}-\mathrm{T}_1) \qquad (1),$$

or $$e = \frac{EC}{\mathrm{S}\,\theta},$$

if we put θ for $\mathrm{T}-\mathrm{T}_1$, the excess of temperature acquired by the wire.

Hence we can determine e for any conductor at any temperature by measuring EC and θ.

Putting $E = CR$, $\mathrm{S} = l\pi d$, and $R = 4\rho l/\pi d^2$ (ρ being the specific resistance in C. G. S. units, l the length, and d the diameter in centimetres), (1) becomes

$$4C^2\rho = e\pi^2 d^3\,\theta,$$

and $$\theta = \frac{4C^2\rho}{e\pi^2 d^3} \qquad (2.)$$

Now, if ρ and e vary together in the same proportion in terms of θ, then $\theta = \kappa C^2$ for any particular wire. That ρ and e do vary together in the same proportion is entirely in accordance with measurement and experiment; and it is interesting to note that it is also in accordance with the researches of Mr. J. T. Bottomley on thermo-radiation (*Phil. Trans.*, vol. 178 [1887], A, pp. 429–450). Thus, if we take the table given on p. 443 of that paper, and work out the variation in resistance of a platinum wire (which variation is the same as for copper) by the usual formula,

$$R_t = \mathrm{R}_0\,(1.0038)^{\theta},$$

we get the values shown in the fourth column :—

Bottomley's researches.			R_t calculated from the formula $R_t = 14.5 \times (1.0038)^{\theta}$.
θ.	C^2/RJs.	e.	
65°	9.45×10^{-4}	14.5×10^{-6}	14.5
110	20.53 "	18.7 "	17.2
232	74.7 "	32.2 "	27.8
383	236 "	61.6 "	48.4
740	1468 "	198 "	187.6
900	3218 "	358 "	344.2

If we determine C for any temperature, then, since $\theta = \kappa C^2$, the current C' producing any other temperature θ' is obtained by means of the equation

$$C' = C\sqrt{\frac{\theta'}{\theta}}.$$

Now, for copper of 1 cm. diameter $C = 2{,}530$ for 1,054°. Thus, if we want to find the current that will raise such a conductor to 13°, we have

$$C' = 2{,}530\sqrt{\frac{18}{1{,}054}} = 281 \text{ amperes},$$

if the surface be equivalent to the assumed normal surface.

Now, since we are dealing with metallic surfaces only, and the normal surface has been defined to be that comparable with the surface when at a white heat, it remains for us to determine the coefficient which shall convert this normal surface emissivity to that of the surface of ordinary wires at low temperatures. This I have done for copper, and the results have been amply confirmed by Mr. Kennelly, in Mr. Edison's laboratory at Orange, N. J., U. S. A.[3]

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[1] A paper read before the Royal Society, May 9, 1890.

[2] G. Roux, *L'Electricien*, December 14, 1889.

Taking the normal surface as unity, then

	Surface coefficient.
Bright and polished copper	0.5
Copper, dirty, oxidized, or blacked with shellac varnish	0.6
Copper, well coated with lampblack	1.0

Taking a wire 1 cm. in diameter and calculating from $C' = 0.5C\sqrt{\frac{\theta'}{\theta}}$ for bright wire, and $0.6C\sqrt{\frac{\theta'}{\theta}}$ for black wire, we get a concordance which is very satisfactory.

5°.				10°.				20°.				40°.				80°.			
Bright		Black.		Bright		Black.		Bright		Black.		Bright		Black.		Bright		Black.	
P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K	P	K
87	85	104	104	123.2	120	148	147	168	169	201	207	243	236	291	290	350	329	420	410

N. B.—"P" means calculated from the formula $C' = 1265\sqrt{\frac{\theta'}{\theta}}$, and "K" means the figures obtained by Mr. Kennelly.

Now, the current (C) producing 1,054° (θ) in a bare bright copper cylinder of 1 cm. diameter is 0.5×2.530 amperes, and that which would produce a temperature of 10°C. is

$$0.5\times2{,}530\sqrt{\frac{10}{1{,}054}} = 123.2 \text{ amperes.}$$

Using both alternating and continuous currents, it was found that in a copper wire with $d = 0.6956$, θ was 50°.3. Now the current (C') that will raise a wire 1 cm. in diameter 50°.3 in temperature is

$$C' = 2{,}530\sqrt{\frac{50.3}{1{,}054}} = 552.7 \text{ amperes.}$$

But the current that will raise a wire of a diameter of 0.6956 cm. through the same temperature is

$$(C \times d^{\frac{3}{2}}) = 552.7 \times .6956^{\frac{3}{2}} = 320.6 \text{ amperes;}$$

or, if the wire be dirty,

$$320.6 \times .6 = 192.4 \text{ amperes.}$$

The current actually was in each case 198 amperes.

A copper conductor, bare and dirty, 20 feet long and 0.415 in. in diameter, was stretched across a room where the air was still, and various continuous currents were transmitted through it. The results are tabulated, and the observed and calculated currents given.

Time.	Increase of temperature of wire. C.	Current in amperes.	
		Observed.	Calculated. $C' = 0.6\,C\sqrt{\frac{\theta'}{\theta}}\,/\,d^{\frac{3}{2}}$
10.45	—	454	—
11.15	86°	454	467.7
12.0	80	450	451
3.30	79	445	448
3.45	78	440	445
4.30	73	429	431
Current stopped; wire cooled. Current put on again at 5.30.			
6.0	38	290	310

Thus, if we know the current producing any fixed temperature in any cylindrical conductor, we can readily calculate the current required for any other temperature.

MEETING OF THE WESTERN GAS ASSOCIATION.

The Western Gas Association held its thirteenth annual meeting at St. Louis on May 21–23. In the course of his address, Vice-President C. R. Faben, Jr., of Toledo, O., said:—

The past year has not been rich with startling developments of new types of apparatus, nor radical changes in existing plans of operation; yet we have progressed. We have improved in many small matters of detail, and have progressed toward that goal that we call perfection. We have dismissed a large measure of the prejudice that formerly molded many of our expressed convictions, even though we may have held at the time an honest opinion to the contrary, yet, on account of our prejudice, we would not give it expression in our utterances.

Water gas is one subject that clearly illustrates to what extremes our prejudice may lead us. The successful application of electricity as a source of light is another. To-day we speak of and regard these projects in an entirely different manner than formerly.

Electric Light.—The electric light as a competitor to gas, for purposes of light, presents a solid front. The arc light has established itself as the best means of lighting large areas, and for street lighting purposes it has no equal. The incandescent electric light is making good, fair progress in many places, and I might say generally. It presents some few advantages over gas that the promoters never fail to appreciate, and they always call the attention of possible patrons to these various little advantages. A naked flame is a dangerous thing to have exposed in many situations that gas jets have been used, and with the incandescent electric lamp quite a display is often made in show windows, stores and private houses, with the light placed and distributed in some unusual manner, the effect of which is novel and at once taking to the average person.

How very profitable to investors these electrical undertakings may be, I question. From statements recently made I find that out of about 100 electric lighting companies in Massachusetts only 15 declared dividends in the past year. Of these 15 companies 10 declared dividends of from 1 to 6 per cent., and only 5 declared dividends above 6 per cent. Leaving out the Boston companies, which by reason of the extent and value of their territory enjoy a greater demand for their light than exists in smaller places, the average of dividends paid by the electric light companies in the State, who paid dividends at all, has been only 4.9 per cent.

Another fact in this connection is that no fund has been created by these several electric light companies to compensate for wear and tear. No depreciation has been charged off. The usual and necessary repair is supposed to represent all of the depreciations, so that the dividends paid are virtually taken from the plant itself or its value. Electric light companies are opposed to having any depreciation charged off other than the cost of repairs and renewals actually made.

The use of the incandescent electric light has demonstrated to my mind the tendencies of the times in the matter of distribution of light. A few years ago many consumers of gas complained of the light produced from burning gas, that it was not of sufficient intensity, and they resorted to the arc light. In many of these situations since that time the arc light with all of its intensity and other desirable qualities has been discarded, and a great number of incandescent electric lamps are used in its stead, so that the present tendency seems to be in the direction of the use of a large number of small lights for indoor illumination, giving to the general illumination something more of a starry effect.

The custom or practice with incandescent electric light companies, in the matter of computing and establishing rates for lighting service, is certainly faulty. No matter how careful and conscientious a consumer may be, the privilege to the free and unlimited use of an article of light leads to great wastefulness. This wastefulness is an item of expense to some one, and, under the conditions cited, it must be a very serious item to the producer. The question of whether or not gas light companies should engage in the supplying of electric light is a purely business proposition, and is determinable only by local conditions. In some situations, yes; in others, no.

THERMO-MAGNETIC APPARATUS.

The two following pieces of laboratory apparatus have been devised by J. Stefan to exhibit thermo-magnetic phenomena. The first, a thermo-magnetic pendulum, consists of a nickel segment attached to the end of a strip of brass, which is movable round a horizontal axis, and is provided above this axis with a sliding weight. When at rest the nickel segment lies between the poles of a horse-shoe magnet. On heating one end of the segment, however, that end immediately moves upwards, and if the heating is continued a regular oscillation may be started. The second piece of apparatus is merely a nickel disc which can rotate around an axis passing through its centre of gravity. The poles of a horse-shoe magnet cover a portion of the rim, and on heating another portion the wheel commences to rotate, and under favorable conditions can be made to revolve at the rate of 60 revolutions a minute.

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[3] A. E. Kennelly "On the Heating of Conductors by Electric Currents." (Abstract of report read before the Edison Convention at Niagara Falls, August, 1889. *Electrical World*, Nov. 23, Nov. 30, Dec. 7, and Dec. 14, 1889).

STANDARD SPECIFICATIONS FOR ELECTRICAL PLANTS.

THE new catalogue just issued by the United Edison Manufacturing Company, besides containing an excellent description of the Edison apparatus and a large number of testimonials as to the merits of the system, embodies a form of standard specifications for electric light plants. These specifications, which we print below, are evidently the result of a large experience in this class of work, and show the high standard adopted by the Edison Company in its installations :

Dynamos.—The dynamo must be of such type and must be so connected as to operate with the highest economy, either separately or in multiple arc (in case there be more than one dynamo), and so that in such case the load may be shifted from one machine to another up to the limit of its full load without in any way affecting the candle-power of the lamps. The dynamo must be capable of being operated for ten hours continuously under conditions of full rated load without injurious heating of any part of the dynamo and without sparking. The dynamo must be of such design that the increase in power required to operate it from least load to full load shall be proportional to the number of lamps in operation. The dynamos must have a commercial efficiency under full load of not less than 85 per cent. in dynamo, requiring three (3) horse-power in belt, and of not less than 92 per cent. in dynamo, requiring one hundred (100) horse-power; and dynamos of intermediate size shall have an efficiency proportional to the efficiencies quoted. The commercial efficiency of the dynamo under conditions of one-quarter load shall not vary more than 8 per cent. from that at full load. Each dynamo must be provided with a belt tightener, so that the tension of the belt may be altered at will while machine is in operation. The armature of the dynamo shall be perfectly balanced, so as to run at its rated speed without appreciable jar. There shall be at least two brushes on each side of the commutator. The insulation resistance between the armature and field coils and the base of the machine must be at least 200,000 ohms. Each dynamo must be placed on a solid wooden base, and must be thoroughly insulated electrically. (When operated continuously for ten hours under conditions of full load, the temperature of no insulated wire or other electrical portion of the dynamo shall rise in temperature more than eighty degrees C. above the temperature of the surrounding air.) All dynamos shall be provided with self-oiling bearings, which, under normal conditions, shall not require attention, except when the dynamo is started.

Instruments.—Each dynamo must be provided with an ampere meter in circuit with it, which shall show continuously the current said dynamo is producing. These ampere meters must be constant, unaffected by any normal change in temperature and unaffected in their readings by being placed at a distance of six feet or more from the dynamo. The ampere meters must be accurate within 3 per cent.

A pressure indicator shall be furnished for each dynamo or set of dynamos operating in multiple arc. This pressure indicator must be connected so as to indicate directly and continuously the electrical pressure at the point to which it is connected. It must be constant in its readings, unaffected by normal changes of temperature, unaffected in its readings by magnetic influences at a distance of ten feet from a dynamo, and must be so constructed that a variation of one volt will cause a deflection of the pointer upon the scale readily noticeable at a distance of ten feet from the indicator.

A ground detector shall be provided which will indicate continuously the condition of each pole of the system as regards insulation to ground.

Incandescent Lamps.—Lamps furnished must be guaranteed to have an average life of six hundred (600) hours and a corresponding economy of fifteen (15) lamps to the electrical horse-power. All lamps shall be of such uniformity when new that when operated at the voltage for which they are intended, both the power required and the candle-power of the lamp shall be within ten (10) per cent. of the rating. All lamps which give out from any fault within the first ten hours of the operation of the plant, shall be replaced by others without charge. All breakage of lamps beyond this, under normal operation of the plant, shall be considered under the guarantee as to average life. Lamps shall be furnished varying in candle-power from sixteen (16) to one hundred (100), there being at least three (3) different candle-powers between sixteen (16) and one hundred (100). Lamps of different candle-power shall require power in proportion to their candle-power.

Pole Line.—The pole line shall be composed of straight, select, shaved poles. All poles must be set perpendicularly, and must be thoroughly guyed, whenever necessary, to insure this result. They must be set one sixth of their length below the surface of the ground. All poles must measure, at least, five inches in diameter at top, and where more than one cross-arm is required, they must measure not less than six inches in diameter. They must be housed and gained. All cross-arms shall be thoroughly seasoned and free from knots, and painted. All cross-arms must be secured to poles in substantial manner, so that they shall be at right angles with line of pole and parallel with each other, and accurately fitted into gains. All poles where cutouts are placed shall be stepped. The poles shall not, under any circumstances, be set further apart than one hundred and fifty (150) feet, and in heavy line work they shall not be set more than one hundred (100) feet apart.

Overhead Conductors.—The overhead conductors shall be of bare copper in systems using less than five hundred (500) volts. The pressure lines and service lines shall be insulated by weather-proof insulation. Whenever the conductors are likely to make contact with other materials than the insulators or poles (except leaves) the conductors shall be properly insulated therefrom. No overhead wire having a span of over ten feet shall be run in closer proximity to any other wire than ten (10) inches. All joints shall be made in substantial manner, so that no movement of the two ends relative to each other is possible, and so that the joint is as strong as the wire itself and makes thorough contact All joints must be soldered. All overhead conductors exposed to influence of atmospheric electricity shall be protected therefrom by suitable lightning arresters.

In all cases where other wires are run above the conductors under consideration, a guard wire must be run to protect the latter from contact with the former.

Wiring and Wiring Devices.—For convenience in reference the wiring will be treated under two heads, the supply wires and the distributing wires.

No distributing circuit shall carry more than five (5) amperes. The distributing circuit shall lead from the distributing cut-outs, which shall be grouped together in cut-out cabinets at various distributing points in the building. Any doors, locks, hinges, etc., if desired for these distributing cut-outs, shall not be furnished by this contractor, but the cut-out cabinet shall be prepared ready for them by the contractor. The maximum loss in any distributing circuit not to exceed two (2) per cent. The cut-outs at each distributing point to be supplied by mains, which mains shall be so proportioned that under any conditions of normal load there shall not be a variation of pressure throughout the mains to exceed two (2) per cent. The connection to the distributing cut-outs from the mains shall be made through double pole fusible cut-outs of proper dimensions. In case current be supplied to the mains through feeders, there shall be fusible cut-outs placed at the points where the feeders join the mains, such cut-outs being placed both at the terminal of the feeder and upon the main immediately on both sides of the feeding point. All lines leaving the dynamo room shall be protected by fusible cut-outs, and in addition thereto any wire leaving dynamo room and carrying a current of more than five (5) amperes shall have a switch in circuit with it. In all molded or concealed wiring where insulation of the wire makes contact with material other than special insulating material designed for the purpose, a wire of following makes, or equally as good grade and acceptable to the purchaser, shall be used : Edison Machine Works, Grade 3, Habirshaw, Okonite, Grimshaw, Kerite, Clark Safety Insulator. In the case of cleated work, where the wire will never, under normal conditions, be exposed to any moisture, an insulation of the quality known as weather-proof can be used, such as the following or their equivalent : Edison Machine Works, Grade 1, P. & B., K. K., Roeblings' Weather-proof, Ansonia Brass and Copper Co.'s Weather-proof. In all work in connection with the wiring, the wire must invariably be handled so that if the wire were bare the insulation would be the highest possible under the conditions. In other words, the insulation must not be relied upon any more than is absolutely necessary. No wire smaller than No. 18, Birmingham Wire Gauge, or No. 16, Brown & Sharp's Gauge, shall be used. In all cases the ampere capacity of the conducting wires must be carefully determined, and the size of the wires so proportioned that the maximum current carried by them under normal conditions shall not occasion a rise in temperature exceeding sixty (60) degrees Fahrenheit. The wiring must be done in such a manner that in case a different system be used from that originally contemplated, there will be the least possible expense involved in changing the wiring to adapt it to any other system. All joints must be made in substantial manner, so that no movement of the two ends relative to each other is possible, and so that the cross-section of contact is at least twice the cross-section of the conductor. All joints, except when surfaces are held in contact by strong pressure, such as by screws, shall be well soldered and well taped. In all cases where the wire is concealed from view the joints shall be thoroughly covered with some first-class waterproof compound before being taped. All wires that pass through floors or that rest against any metal work shall be protected by a tubing of hard rubber extending at least one inch in each direction beyond such floor or metal work. With all safety devices open, the insulation of any single section of the wiring shall not be less than 100,000 ohms. The combined insulation resistance, when all sections are connected up for service, shall be the highest obtainable when each section measures 100,000 ohms. Metallic staples for fastening wires shall not be used unless there be placed between the insulation of the wire and the staple some insulating and non-combustible material. Electric light fixtures or gas fixtures carrying electric light wires, if attached to gas pipes, must be insulated therefrom by insulating joint or other suitable means, so that there shall be a high electrical resistance between such electric light wiring, such fixtures and the system of gas pipes. The wiring must be so proportioned that the maximum variation of electrical pressure at the lamps in different parts of the building under any normal conditions shall not exceed two (2) per cent. All wiring must be neat in its mechanical appearance and arrangement. All points in regard to wiring not above specified shall conform strictly to the requirements of the National Board of Fire Underwriters. All cut-outs shall be made of insulating and non-combustible material, such as porcelain, glass, etc., and shall be double poled. All switches shall be mounted upon insulating and non-combustible bases, and if covered, shall be so designed that the switch is merely set by hand ready for the break in contact, and the actual breaking of contact shall be done automatically and beyond hand control. The act of making and breaking contact in all switches shall cause the surfaces in contact to be subjected to sliding friction in order to keep such surfaces of contact clean. All sockets shall be of same dimensions relative to the base of the lamp, so that any standard Edison lamp of any candle-power will fit any socket. The socket shall be of substantial, workmanlike construction, and all portions of the shell and key shall be thoroughly insulated.

ON AN ACCIDENTAL ILLUSTRATION OF THE EFFECTIVE OHMIC RESISTANCE TO A TRANSIENT ELECTRIC CURRENT THROUGH AN IRON BAR.[1]

BY SIR WILLIAM THOMSON.

The wonderful accidental experiment of Lord Armstrong may briefly be described as follows:—A bar of steel which Lord Armstrong was holding in his hand was allowed accidentally to come in contact with the two poles of a dynamo giving 85 amperes and 103 volts. A painful sensation of burning was instantly felt and the bar was dropped. Severe blisters occurred where the hand or the fingers touched the bar, which was found immediately afterward to be quite cold, or not perceptibly hot. This marvelous incident proved: (1) the outer surface of the steel to have been intensely heated; (2) that not enough heat was generated to sensibly warm the whole bar. The explanation, of course, is to be found in the known laws of diffusion of electric currents through non-magnetic conductors, considered in connection with the effect of magnetic susceptibility, of unknown amount and law, in conductors of steel and iron.

The requisites for working out fully the theory of transient or periodic currents in conductors of any form are included in Maxwell's fundamental equations, and are given explicitly for straight cylindric conductors of non-magnetic material in sections 685–689 of his work. Lord Rayleigh, in his paper "On the Self-Induction and Resistance of Straight Conductors" (*Phil. Mag.*, May, 1886), gives the formula for transient or periodic currents in straight cylindric rods of iron, on the supposition of constant magnetic susceptibility. The details of this highly interesting and important branch of the subject have also been investigated by Heaviside in a very comprehensive manner. The tendency of periodically alternating currents to be condensed on the outer part of a cylindric conductor, while the current may be exceedingly feeble or quite insensible in the central parts, was discussed and explained by Lord Rayleigh in page 388 of his article already referred to, and its aggravation in an iron conductor specially pointed out. The same considerations show that a transient current resulting from the application, for a very short time, of the electromotive force of a voltaic battery, or of electro-magnetic induction acting not directly on the cylindric conductor considered, but on a conductor such as the inductor of a dynamo of any kind, momentarily in circuit with it, is only skin deep if the duration of the electromotive force be but short enough; and that the depth to which the current penetrates in a given very short time is much smaller for iron than for copper.

THE NON-CONDUCTIVITY OF A VACUUM.

In a recent paper in Wiedemann's *Annalen* on "The Electrical Conductivity of Gases," T. Homen denies the validity of Foeppl's so-called experimental proof of the non-conductivity of a vacuum described in vol. xxxiii. of the *Annalen*. Homen points out that the length of path to be traversed by the discharge in Foeppl's experiment must have been at least 13 metres. Now, his own recent experiments show that in an electrical discharge through rarefied gas there is an addition to the true ohmic resistance, a resistance of the nature of a counter E. M. F., and for a length of path of 13 metres, and a pressure equivalent to 0.09 millimetre of mercury, the value of this counter E. M. F. would be about 5,200 volts, and as at this pressure the counter E. M. F. diminished as the pressure increased, it would probably be greater for higher vacua. The E. M. F. of about 270 volts employed by Foeppl could not, therefore, be expected to produce a discharge.

DEATH OF CARL FRISCHEN.

The death is announced on May the 8th., of Herr Carl Frischen chief engineer to Messrs. Siemens and Halske, of Berlin. He was born at Bremen in 1830, and apprenticed at an engineering works in that town, subsequently studying at Hanover. He afterwards entered the service of the Hanoverian Government, and in spite of his youth was entrusted with the superintendence of the erection of railway telegraphs, and shortly afterwards he was appointed chief of the Hanoverian telegraphs. In that capacity he was the inventor of numerous practical arrangements and improvements. In 1856 Herr Frischen invented a duplex telegraph simultaneously with Herr Werner Siemens, and in that way his name became more widely known. In 1867 Herr Frischen entered the telegraph service of the North German Confederation, and for some years held in Berlin the office of chief telegraph engineer, but afterwards, in 1870, accepted an offer of Messrs. Siemens and Halske to enter their service as chief engineer. His inventive capacity, combined with his practical turn of mind, found full scope in the large and diversified works of the firm, extending to all branches of electricity. About four years ago his health suffered from the effects of a serious operation, and although appearing restored a fatal result has unfortunately ended an interesting and useful life.

VERIFYING THE PHENOMENA OF ELECTRIC REPULSION.

The important task of verifying some of Prof. Thomson's results by careful measurement has been undertaken by M. Borgmann, who, in a number of the *Comptes Rendus*, describes several quantitative results he had obtained. The primary magnetizing current was measured by a Siemens dynamometer, and the repulsive forces exerted on a disc were weighed by means of a delicate balance. The repulsive force was found proportional to the mean square of the primary current; it diminished as the distance between the disc and magnetizing solenoid increased; it diminished with the diameter, and increased with the thickness of the disc. For discs of the same dimensions, but of different metals, the repulsion diminished with the specific resistance, although in a less proportion, owing to self-induction; and, as the frequency of the current was increased, the forces were found to diminish, the product being about constant. Although several of these results are only what theory would have predicted, it is the first time they have been experimentally shown.

BOILER CLEANING BY MAGNETISM.

At the 10th Annual Convention of the American Water Works Association, recently held at Chicago, Mr. Bull, of the Committee on Electrical Boiler Devices reported the results of the experiments made by him to obtain a method of overcoming the scale in boilers by the employment of magnetism. The first apparatus used by him consisted of an electro-magnet attached to the mud drum of a boiler; another electro-magnet attached to the feed drum; and an iron yoke connected to the two magnets, which magnets were excited by a small dynamo. His first theory regarding the action observed was that the operation was a mechanical one, the result of a rapid polarization and depolarization of the boiler by means of an interrupted or alternating current setting up something like a vibration in the shell and tube, which prevented a lodgment of scale upon their surfaces, the mineral being kept, as it were, dancing like a grain of sand upon a vibrating plate.

Having heard of the experiments of Mr. Frazer, who aged wine by means of the application of magnetism in California, he saw fit to change his views and modify the construction of his apparatus accordingly. One of the changes made by him consisted in the substitution of permanent steel bar magnets in place of the electro-magnets as a source of magnetic energy. In the present type of apparatus, the magnets are ranged within a cylinder in sheets and bundles. They are made of plate bars of hard steel and are somewhat separated to permit of an uninterrupted passage of the feed water. In a cylinder of 10 inches in diameter there are about 150 magnets made of ¼ inch steel, 1 inch in width and of varying lengths from 3 to 10 centimetres.

A test was recently made on a boiler in a lime burning establishment near Quincy, Ill., the boiler in question being fed from a well at the edge of a limestone quarry. The water was perfectly clear to the eye, free from organic matter and all visible impurities, but chemical tests showed it to be one of unusual hardness. It was, in fact, so bad that the tubes in this particular boiler are renewed twice a year on account of the scale which forms on them. It was a fact that in ten days a heaping shovelful of sand or disintegrated scale was taken out, and after a few more weeks not less than three shovelfuls of the same were removed, mixed with fragments of friable scale.

Prof. A. R. Leeds, of the Stevens Institute of Technology, Hoboken, discussing the paper of Mr. Bull, called attention to the fact that about twenty-five years ago, the Franklin Institute had experimented in this direction and had obtained promising results.

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[1] Abstract of paper read before the Royal Society of Edinburgh, March 17th, 1890.

That for some reason the promises had not been fulfilled and the matter had been dropped. The plan then in use was to fix permanent magnets to the crown sheets of the boilers and connecting them by wires to the forward end of the boiler.

CORRESPONDENCE.

BOSTON.

Captain Brophy in the West—West End Increase—N. E. Electric Exchange—Thomson-Houston Stock.

CAPT. BROPHY is making an extended trip through the West, examining electrical risks for the Electric Mutual. His trip has covered a period of over six weeks, and he has inspected over 50 stations.

The West End Street Railway Company are still continuing to increase their facilities, and have applied to the selectmen of Brookline for permission to erect a car house on Chestnut Hill avenue.

Mr. H. C. Spaulding, of the Thomson-Houston Electric Co., has been elected treasurer and secretary of the N. E. Electric Exchange, vice H. H. Fairbanks of Worcester, resigned. Mr. Fairbanks takes the seat at the board vacated by Mr. Spaulding in his acceptance of the treasurership.

Application has been made to list the negotiable receipts issued by the American Loan and Trust Co. for Thomson-Houston stock deposited under the circular of May 26. It is reported that about 75 per cent. of the stock has been deposited with the American Loan and Trust Company.

The West End elevated road bill has been taken up again this week by the legislature, and a number of amendments acted upon. The house adopted an amendment giving the board of aldermen authority to grant the location for the elevated tracks, with the approval of the Mayor, and the assent of the railroad commissioners. Other amendments of greater or lesser importance were also adopted, but no definite result has yet been reached in the main question, and the bill has been passed to be engrossed. The Meigs bill has been enacted without debate. Mr. Howland, of Chelsea, moved a bill as a substitute for an adverse report on allowing cities and towns to make and sell gas and electricity. To his bill he offered a further section that, "If in any city or town there exist at the time of the passage of this act, gas or electric light plants, owned or operated by persons or corporations acting under the laws of this commonwealth, such plants shall be purchased by said cities and towns," in the manner provided in the bill before they go into the business themselves. The price paid for the property is not to include the value of the franchise or of any privileges, but only the cash value of the property, to be fixed by three persons selected in a specified way, their decision to be final when accepted by vote of the city or town.

Speaker Barrett appointed Messrs. Hildreth of Holyoke, Sandford of Boston and Lyons of North Adams (each of whom is on record against the bill) as a committee of conference on the bill for the consolidation of gas and electric light companies.

BOSTON, June 7, 1890.

ST. LOUIS.

Electric Railway Work—Names of Streets on Lamp-posts—The Municipal Company's Station.

THE following bills have been introduced before the Municipal Assembly for electric railway privileges.

The St. Louis Cable and Western ask for the privilege of equipping with electric power east of 23d street. They already have an ordinance for equipping west of 23d street.

The Southern Railway ask for the privilege of constructing a branch from Seventh and Ann avenues to Tower Grove Park, the same to be operated by electric power.

The Southwestern Railway and the St. Louis and Suburban Railway, two new schemes, asked for the privilege of constructing electric roads.

The Laclede Gas Company having removed their gas lamps from the streets, the city is left without street names, and the Board of Public Improvements are considering devices for street nomenclature, one of which is to purchase or lease of the gas company such lamp-posts as may be required and light them with small incandescent lights.

The track laying and wiring of the down town section of the Union Depot Railroad Company will be finished and electric cars will be running to Fourth and Pine streets early this month. This will be the first electric railway to reach the down town district.

The Municipal Electric Lighting and Power Co. will hold their annual meeting for the election of officers on June 2d. The mammoth station of this company attracts widespread interest. The Western Gas Convention during their stay in the city, visited the station almost in a body. The officers of the Evansville Gas Co. also made a visit to the station.

ST. LOUIS, June 4, 1890.

PITTSBURGH.

Electric Railway Work—Electrical Litigation—Westinghouse Plans.

The St. Clair electric road of this city has put several new cars on its line for the accommodation of the enormous increase in the patronage of the road.

Mr. James Hunter, of the Allegheny County Light Company, addressed a large meeting of stationary engineers the other day on the subject: "The alternating current system for incandescent and arc lighting and the direct current for motor service." The address was made in the rooms of the National Association of Stationary Engineers.

At a meeting of the Councils of Braddock, Pa., W. F. Cook, Esq., of Pittsburgh, as the representative of a street railway company, made a petition before that body to obtain the right of way through the borough for an electric street railway to Wilmerding. The latter place is a new town founded by Mr. George Westinghouse, Jr., where the new shops of the Westinghouse Air Brake Company are located.

The case of the citizens of Hiland avenue against the Hiland Avenue Electric Company came up before Judge White a few days ago. The plaintiffs brought the suit to prevent the construction of the line on Hiland avenue, because they claim it will spoil their property. The judge at once granted a preliminary injunction pending the hearing of the case.

The suit of the Pittsburgh Traction Company against the Duquesne Traction Company came up last Wednesday for a hearing before Judge Paxon in the Supreme Court of Pennsylvania at Harrisburg. The case originated from the fact that the Pittsburgh Traction Company claimed the right of way on certain streets upon which the defendant corporation is now laying tracks for an electric road. The judge dismissed the case and ordered the costs to be paid by the plaintiff company.

The directors of the Westinghouse Electric Company held a special meeting in the Westinghouse building, this city, June 4th, and passed the following resolutions:

Resolved—That a meeting of the stockholders of this company be called to be held at the office of the company, Westinghouse building, Pittsburgh, Pa., on July 8, 1890, at 2 o'clock, p. m., for the purpose of taking such action as shall be necessary to transfer the business of the Westinghouse Electric Company to the Westinghouse Electric and Manufacturing Company, and to transact such other business as may be brought before the meeting.

Resolved—That a meeting of the stockholders of this company be called to be held at the office of the company in the Westinghouse building, Pittsburgh, Pa., on July 8, 1890, at 2 o'clock, for the purpose of holding an election for or against the increase of the capital stock of the company; that notice hereof be published by the secretary as required by law, and that the transfer books be closed from July 1 to July 8, 1890, both inclusive.

It was also learned at this meeting that all of the regular stock of the Westinghouse Electric Company has been transferred to the Westinghouse Electric and Manufacturing Company, so that at the time of the meeting a formal action may be assented to and the business thereafter conducted by the Westinghouse Electric and Manufacturing Company. The aggregate sales of the Westinghouse Electric Company and its leased companies amounted to $4,362,000 in the year 1889, and for the first three months of this year, in the lighting business alone, the increase over the same period of last year was about 80 per cent. Beginning with the month of May the company has taken orders for the supply of railway equipment and contracts have already been closed during the one month for upward of $200,000 of material, with negotiations well advanced for more than four times that amount, indicating that for the year 1890 the sales of the company will be greatly in excess of last year.

PITTSBURGH, PA., June 6, 1890.

SAN FRANCISCO.

Personal Items--Electric Railway Work—Laying the Honolulu Cable.

J. B. GILL has disposed of his interests in the San Francisco district system, and with his improved "call box" has established himself in Cleveland, O., where he has contracted to do the entire Western Union delivery in conjunction with other district business.

Since the death of Geo. S. Ladd, his successor, John I. Sabin, is not allowing grass to grow under his feet. He is in everything in which a dollar can be turned with interest. His last is the Auxiliary Fire Alarm and the Municipal Police Telegraph.

James Gamble is still in the electric field, and is as positive and as energetic as when he pioneered the first wire over the Sierra Nevada mountains. He is building an electric railway from Oakland to Berkeley, which will be on the overhead wire system. Mr. Gamble would have nothing to do with any other system than the overhead, which he claims is the only one for this climate. It will command a fine view of San Francisco Bay and the Golden Gate, as well as being a boon to suburban residents. He expects to have it in operation by July 1st.

James Power, who was telegraph operator with General Roberts in Afghanistan, and who drew lots with a half-caste to accompany the ill-fated though brave Captain Louis Cavignari to Cabul, is now engaged laying cables connecting the Hawaiian group, with headquarters in Honolulu.

San Francisco, Cal., June 1, 1890.

REPORTS OF COMPANIES.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY.

This company has just been organized for the purpose of manufacturing and selling storage batteries solely, with Mr. Wm. Bracken as president. The company owns the Julien storage battery patents—more especially that for the inoxidizable support plate—and the exclusive right to use for the whole of the United States all the Brush storage battery patents and inventions. Principal among these are the Brush patents, Nos. 337,298 and 337,299, covering the mechanical application of any absorptive substance to a conducting support; and the Brush patent, 266,090, which covers a support plate or a conducting support with receptacles for the active material; in addition to these, also, the Brush patent No. 260,654, which covers the application of oxide of lead to the support plate by pressure. The new company also owns the mechanical filler patents of Morris and Salom, which cover the process and machine for filling the conducting support or grids with active matter. They are more especially capable of doing this when the active matter is applied in the form of a powder. The two first mentioned Brush patents run 13 years from May, 1889; the mechanical filler patents have about 16 years of life, and the Julien storage battery patent, No. 347,300, being for his inoxidizable support plate, has about 14 years to run.

The Julien Electric Traction Company has sold its cars and everything in relation to traction to the United Electric Traction Company, the latter company having bought not only all the traction interests of the Julien Electric Traction Company, but also all the Daft companies, including the Daft Electric Light Co., with its factory at Marion, N. J., the Daft Electric Power Co., with its three stations in New York, and the Daft Electric Power Co. of Newark, and the Daft Electric Power Co. of Philadelphia. The United Electric Traction Co. have also purchased the Chamberlain battery rack patent. The United Electric Traction Co. has acquired from the Julien Co's. such patents relating to the application of storage batteries to the propelling of street cars, as will enable that company to make storage battery traction a specialty, but according to Mr. Bracken, there is no understanding, oral or written, between The Consolidated Electric Storage Co. and The United Electric Traction Co. as to the sale of batteries to the Traction Co. or as to favoring them in any way over any others desiring batteries for traction.

It will be the policy of the Consolidated Electric Storage Co. to furnish batteries to everybody on equally favorable terms. As indicating the demand there is for storage batteries, Mr. Bracken states that their Camden factory sold last month 1,294 accumulators although they have not a single agent in the field soliciting orders.

THE UNITED EDISON M'F'G CO.

From information imparted to us by the United Edison M'f'g Co. it would appear that the electric light business in isolated plants and small central stations continues to grow in a very marked and satisfactory manner:—

The increase on the sale of dynamos by the "Cash Installations Division" of the United Edison M'f'g Co. during the month of April this year shows 204 per cent. more than for the corresponding month in 1889, together with a greater percentage of lamp capacity of the dynamos. The dynamos have been installed in all parts of the Union, from the Golden Gate City to small villages in Maine—from New Orleans, the Queen City of the Gulf of Mexico, to the newly settled districts in the far northwestern territories.

The lamp sales have also vastly increased; the percentage of increase for the month of April being 116 per cent. more than for the corresponding period last year, showing, it is claimed, that the policy of the Company in mounting Edison lamps with bases to fit the various sockets that are in use, thus enabling consumers operating plants other than Edison to secure the benefit due to the Edison lamp, has been a wise one.

The United Edison M'f'g Co. for the past eight months have been gradually getting their business in shape to attend to all construction themselves and to supply their plants with the various materials they need. All construction work for the Edison System throughout the United States and Canada, is now done by the Company under a very comprehensively organized construction force.

The company have also established a depot of supplies in Chicago, Denver, San Francisco and Canada, in addition to a New York depot, and now carry in each one of these localities a complete stock of dynamos, lamps, sockets, switches, cutouts, wire of various makes, in fact, all materials which are used in connection with electric light and power plants. This arrangement is proving extremely satisfactory to the purchasers and owners of Edison plants, as the Company are now enabled to install a plant upon short notice and are able to furnish any supplies required immediately, from stock at a short distance from the purchaser.

It has been accepted generally by the Electric Light Companies that the summer months show an unusual falling off both in regard to lamp sales and installations. But from the amount of business that is being done and the orders that are being placed, this Company will, it is believed, prove a notable exception to the rule this summer.

THE PULLMAN-WESTINGHOUSE "DEAL."

The principals in the arrangement between the Pullman and Westinghouse interests are very reticent as to the rumors now afloat, but the subject is a prominent topic in more than one city. A special despatch from Pittsburgh, of June 3, says:—"The stock of the Westinghouse Electric Company is to be increased $3,000,000, or from $5,000,000 to $8,000,000. Pullman, the car-builder, is to take the entire issue at par or $50 a share. The incentive with Mr. Pullman is the manufacture of cars for electric street railway lines. The Westinghouse Company will both build and equip the cars. Details of the deal are now being arranged."

A later despatch of June 5, from the same city, says:—"Sixteen miles up the Allegheny river, at Parnassus, 850 acres of land have just been secured as a site for extensive electric car works, to be erected jointly by the companies controlled by George W. Pullman and George Westinghouse, Jr. The details of the new enterprise have not been given out, but Mr. Pullman will look after the car works, and Mr. Westinghouse will control the electrical appliances. Announcement is also made that on July 8, the stockholders of the Westinghouse Electric Company will pass upon the proposition to transfer its business to the Westinghouse Electric and Manufacturing Company. It is also proposed to increase the stock from $5,000,000 to $8,000,000. President Westinghouse favors this plan, and in support of it quotes $4,362,000 as last year's business, and says that during May orders for $200,000 worth of railway equipments alone were taken, to say nothing of the other lines of business."

These reports have had their effect on the stock market. The New York Stock Exchange reports say as to Pullman stock:—"The advance to 20) was accomplished on light purchases, the stock being as usual put up sharply against bids. What may possibly have had something to do with the advance was the announcement that the Westinghouse and Pullman people were about to put up a large establishment near Pittsburgh, for the manufacture of electric cars, 300 acres of land having been purchased for the purpose."

THE MINNEAPOLIS EDISON EXHIBITION.

Mr. Luther Stieringer, the well known expert, who has been called upon by the management of the Minneapolis Exhibition to assist in the preparation of the electrical plans this year, returned to this city en route for the South, where he will enjoy a brief vacation. As is already known, the main feature of the Exhibition will be the Edison exhibit from Paris, recently displayed at the Lenox Lyceum. This, however, will be supplemented by some special novelties, and the "Tower of Light" effects will be repeated, though upon a scale that is far beyond anything yet attempted. We have had the pleasure of looking over the plans, and can only say that if they are carried out, even approximately, the effects at the Lenox will be cast into utter insignificance. Minneapolis is fortunate in having such an opportunity, and there is no doubt that the exhibition will interest and attract the whole Northwest.

DELAY IN THE KEMMLER CASE.

In the general term of the New York Supreme Court at Buffalo, on June 3, the decision of Judge Underwood, of Auburn, in the Kemmler habeas corpus case was affirmed. This allows the case to go at once to the Court of Appeals. The only question at issue is whether Kemmler can be legally executed by the warden of Auburn prison.

The Elgin, Ill., Electric Light and Power Co., have just incorporated, with $100,000 capital. This company will install immediately extensive Wood arc and Slattery induction systems of lighting, having closed contracts therefor with the Ft. Wayne Electric Company through the latter's Chicago office.

SOCIETY AND CLUB NOTES.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

The ninth annual meeting of the Association of Railway Telegraph Superintendents will be held at the Cataract House, Niagara Falls, N. Y., on Wednesday, June 18. The support given to the Association by leading railroads, and the success with which it has been attended since its formation on Nov. 20, 1882, in elevating the standard of employees and eliminating those of objectionable records from the service, have been very gratifying, and the coming meeting is expected to be one of the most important yet held. Papers are to be read on various topics, signals, electric devices, etc. It is desired that as many railroads as possible be represented. Any officer in charge of operators is eligible on the payment of $3 membership fee, which includes all dues for the year. The officers of the Association are: C. A. Darlton (Richmond & Danville), President, Washington, D. C.; G. T. Williams (New York, Chicago & St. Louis), Vice-President, Cleveland, O.; P. W. Drew, Secretary, 535 Sixty-seventh street, Englewood, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The last meeting of the Institute for the current season 1889–90, will be held at 8 p. m. on June 17, at the house of the American Society of Civil Engineers, 127 East Twenty-third street, when two papers will be read, one by C. Humphrey and W. H. Powell on "The Efficiency of Transformers," and the other by Prof. H. J. Ryan, entitled, "Notes upon Some Experiments with Alternating Current Apparatus." These two papers sum up the latest work at Cornell University in this field, and will prove very valuable and interesting additions to the literature of the subject as well as to the Institute *Transactions*, now in such high and well deserved repute at home and abroad.

THE ELECTRIC CLUB OF NEW LONDON, CONN.

The Electric Club of New London, Conn., has been organized. The officers are Ernest W. Bruch, president; James R. Troland, treasurer, and Clarence W. Ford, secretary. The club starts out with a small membership, but expects to grow and be useful in its district.

LEGAL NOTES.

DOUBLE CARBON ARC LAMPS.—BRUSH ELECTRIC CO. *vs.* SPERRY ELECTRIC LIGHT CO.

In the suit of the Brush Electric Co. against the Sperry Electric Light Co. for infringement of Brush's patent, No. 219,208, for double carbon arc lamp, an injunction was granted Monday, June 2, by Judge Gresham against the defendants, to go into effect in thirty days. This result will be noted with great interest by manufacturers of arc lighting apparatus generally.

PATENT NOTES.

A BILL TO INVALIDATE UNUSED PATENTS.

A special despatch from Washington, D. C., calls attention to the Simonds patent bill now before the House of Representatives. The fifteenth section of this measure, as reported from committee, provides that within five years from the date of issue of each patent "some person interested in or under the same" shall pay a tax of $10 upon the same to the Commissioner of Patents, or in default of such payment the patent shall expire; and within another five years an additional tax of $25 must be paid in like manner to keep the patent alive still longer.

The theory upon which this proposed change in the law proceeds is that the protection of the government is now extended to a great mass of inventions which are not only of no use to their inventors or to the world, but which are actually an obstruction to the free action of the national genius. While they remain alive no inventor dares invade their especial field for fear of involving himself in expensive litigation. Thus, not only is an injustice done to men who might meanwhile be making headway with really valuable devices of their own, but the public suffer a wrong in being deprived of the use of improvements which they might just as well be enjoying. In the great majority of cases the worth of an invention, if it has any, is discovered in a few years, for it is during that time that the inventor himself is most enthusiastic and active in bringing it to the notice of capitalists and trying to put it upon the market. While the chances of success seem fair he places a high estimate on the value of his device. After it passes a certain point, however, he is apt to become somewhat discouraged, and then it is proposed to offer him the alternative between proving his faith by the payment of $10, and letting his patent rights expire. It is the common rule with devices which have an outward look of excellence, but little practical value, that, having exhausted his resources in striving to interest capitalists, the inventor sells out for a trifle to some speculative concern; a stock company or "syndicate" is then organized by the aid of generous advertising, and the innocent investors, who usually know nothing about patents or patent law, never see a penny of their money again in the form of either principal or interest. It is believed by the friends of this bill that these speculative sales will be less frequent when the purchaser either has to pay a tax at the outset in order to keep his patent alive, or knows that at the end of the next five years he must pay a still larger tax or let the whole thing go.

Of the three points urged against the bill by patent lawyers, the first is that it would tend to discourage invention by adding to the burdens of the patentee; but to this the response is that the present cost of a patent is no deterrent, while the indications are that the fees might be doubled without materially lessening the number of applications. The second complaint is that the terms of the bill are too indefinite. If "some person interested" is required to pay the tax, there is always danger of its lapsing through inattention or accident; but to this it is answered that the Commissioner of Patents will be called upon to formulate a system by which the whole business can be conducted without injustice to any one. The third fault found with the taxing programme is that it is needlessly complicated. There seems to be some just ground for this criticism. If, instead of two payments at various times, a single payment were required—say $25—at the end of the seventh or eighth year, it would answer the same final purpose, and meet the more cordial approval of experts who dislike to see our patent system loaded down with technicalities any further than is required for the protection of inventors and the public. Finally there is a plea that the plan is borrowed from the English system.

INVENTORS' RECORD.

Patents issued June 3, 1890.

Alarms and Signals:—*Indicator for Elevators*, J. P. Cushing, 429,189. *Electric Fire-Alarm and Extinguishing Apparatus*, C. E. Ongley, 429,318. *Electric Call and Voting Apparatus*, T. M. Wilkins, 429,330. *Watchman's Time Recorder*, J. F. McLaughlin, 429,360.

Clocks:—*Electrical Clock-Winding Mechanism*, A. Ward, 429,396.

Conductors, Conduits and Insulators:—*Cover for Electric Subways*, J. Stafford, 429,251. *Machine for Stripping the Lead Covering from Conductors*, D. Thatcher, 429.292. *Electric Conductor*, H. B. Cobb, 429,304 and 429,305. *Joint for Electric Conductors*, H. B. Cobb, 429,306. *Underground Conduit for Electric Wires*, H. B. Cobb, 429,307. *Apparatus for Covering Wire with Plastic Material*, D. D. Parmalee, 429,581.

Distribution:—*Process of Maintaining a Uniform Current in Electric Circuits*, J. M. Bradford, 429,333. *Electrical Converter*, G. Pfannkuche, 429,583.

Dynamos and Motors:—*Apparatus for Rectifying Electric Currents*, F. Anderson, 429,109. *Field-Magnet for Dynamos*, E. Wagemann, 429,490.

Lamps and Appurtenances:—*Portable Electric Lamp*, J. H. Irwin, 429,172. *Manufacture of Carbon Filaments*, A. de Khotinsky, 429,534 and 429,535. *Electric Arc Lamp*, C. F. Keller, 429,573.

Medical and Surgical:—*Medical Battery*, F. P. and W. A. Hoeneman, 429,447.

Miscellaneous:—*Apparatus for Detecting Leaks in Pipes*, W. W. Rosenfeld, 429,286. *Electric Heating Apparatus*, C. E. Carpenter, 429.559 and 429,560. *Method of Electric Heating*, C. E. Carpenter, 429,562.

Metal Working:—*Electric Soldering Iron*, C. E. Carpenter, 429,561.

Railways and Appliances:—*Electro-Magnetic Locomotive*, R. N. Allen, 429,107. *Trolley-Carrier*, B. F. Brown, 429,113. *Electric Railway System*, W. D. MacQuesten, 429,199. *Electric Tramway and Car*, A. L. Lineff, 429,277. *Continuously Operated Electric Motor*, W. D. MacQuesten, 429,314. *Electric Railway Motor*, F. J. Sprague, 429,327. *Trolley for Electric Railways*, W. S. Blauvelt, 429,413. *Interlocking Electric Railway System*, J. Ramsey, Jr., and F. C. Weir, 429,478. *Electric Railway Signaling Apparatus*, C. H. Rudd, 429,483. *Electric Railway Signal*, H. A. Parmalee, 429,582.

Secondary Batteries:—*Electrode for Secondary Batteries*, C. Hering, 429,272 and 429,274. *Secondary Battery*, C. Hering, 429,273.

Telegraphs:—*Printing Telegraph*, J. Burry, 429,115. *Multiple Telegraphy*, E. N. Dickerson, Jr., 429,233. *Telegraphy*, S. M. English, 426,377. *Printing Telegraph*, A. T. McCoy, 429,576 and 429,577.

Telephones and Apparatus:—*Magneto-Telephone*, N. B. Ginochio, 429,129.

THOMAS, SHEPARD & SEARING.

We take pleasure in noting an advance in engineering interests in the West by the recent establishment of Thomas, Shepard & Searing, of Denver, Col., who are making a specialty of a higher class of work than has hitherto been attempted in that part of the country. We quote the following from their circular :

"Besides acting as expert and consulting engineers, giving advice and testimony on mechanical and electrical problems, we will give special attention to the following classes of work : Tests of engines, boilers, machinery and electrical apparatus. Experiments and researches on material and processes. Development of inventions and design of special machinery. The accurate determination, by means of the Emerson power scale, of the power required to drive machinery."

Messrs. Thomas and Shepard are graduates of the Mass. Institute of Technology, and Mr. Searing is a graduate of Stevens Institute of Technology. All the members of this firm are young men and all have had considerable experience in experimental research either under great scientists or in large manufacturing establishments, and we feel confident that the courage which backed them in making this venture will carry them through to success.

THE BAKER COMMON-SENSE OIL FILTER

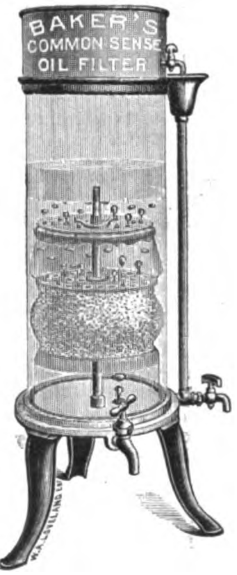
With the dawn of the high-speed engine, the dynamo and motor, there came demands for a more plentiful and constant supply of lubricating oil, of a somewhat lighter and more even quality than had before been generally used. The high cost of the oil soon led to catching it and using it over a second time. This same created the necessity of a proper oil filter to work perfectly, as oil seems "sticky" in relation to dirt.

Some four years ago, Mr. C. F. Baker, chief engineer for C. A. Pillsbury & Co., of Minneapolis, produced, as a result of several years' experimenting, a filter that seemed to be perfect for the purpose. The assistance of Mr. W. E. Crane was obtained, and it was put into shape to manufacture on a large scale.

It has now been so long in extensive use, and particularly in electric light plants, that it is fast becoming a familiar and necessary adjunct for establishments of this kind.

In the "Common-Sense" oil filter, as it is called, the filtering material is entirely submerged in water, and is enclosed in the upper part of two bell-shaped glasses, as shown in the accompanying illustration. The oil is fed from the tank on top down through the side pipe, thus entering the filter at the bottom, near the centre. Its lesser specific gravity causes it to rise through the water, and accumulate beneath the filtering material, being enclosed by the glass bell.

By capillary attraction and its gentle pressure upward from its lightness, the oil gradually goes up through the filtering material in the lower glass bell and is caught and required to pass through the upper one containing a different filtering medium, in the same manner. The clean oil accumulates on top of the water, and is drawn off at the front faucet, which communicates with the central pipe. The water is drawn off at the side faucet.



BAKER COMMON SENSE OIL FILTER.

A short consideration of the construction of this filter makes it very evident that it is constructed on scientific and common-sense principles. The gravity of the oil is reversed and diminished to less than one-tenth by the presence of the water. The gravities of the metallic and all other impurities, have the gravity of the water subtracted from theirs, leaving them with only a slight inclination to drop, while the gentle but sure tendency of the oil to rise while passing through the filtering medium effects a most natural and perfect separation, which does not soon clog up the filtering material, and bottle samples fail entirely to show any settlings in the filtered oil.

The filters have been highly endorsed by well-known electricians and engineers, and are claimed to pay for themselves in a very few weeks, admitting of the oil being used over as many as forty times in some cases. A great benefit arises from the fact that the machinery may be amply oiled without stint. They are made of a very tough quality of glass, and the whole operation is visible. The construction is such that they may be taken apart entirely by simply unscrewing two thumb-nuts.

The filter, which occupies but little space, and is an ornament to the dynamo or engine room, is manufactured only by Walter E. Crane, of Minneapolis, Minn.

NOISELESS SOLID RAW-HIDE GEARS.

In many situations it is necessary to employ gear wheels running at a high rate of speed, and the wear which takes place under those conditions, together with the accompanying noise, makes their use objectionable. Many attempts have been made to overcome these defects but probably the most successful has been the substitution of some fibrous, non-resonant material instead of the metal gears heretofore employed. Of these materials the patented solid raw-hide gears made by the New Process Raw-hide Co., of Syracuse, N. Y., have met with remarkable success.

In the manufacture of the raw-hide, great pressure is applied, and all superfluous matter eliminated, leaving the same extremely light and making it the strongest material for its weight known.

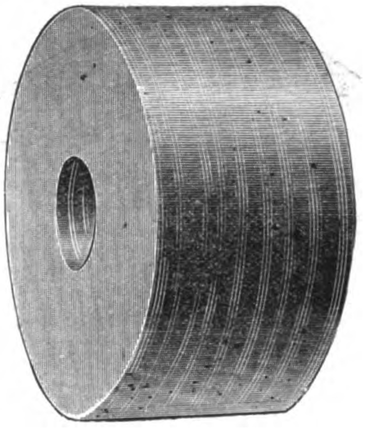


FIG. 1.

The accompanying engraving, Fig. 1, shows the blanks as manufactured for spur and bevel gears, and Fig. 2 shows the finished gear. These gears, as is well known, have come into extensive use on electric cars, where their silent and even operation has added much to the comfort afforded by these cars. These gears may be run together or against metal gears, and require no lubrication. These raw-hide gears have been in operation for some time. Thus, on the East Harrisburg Passenger Railway some of the raw-hide gears made by the New Process Raw-Hide Co., have run 18,000 miles without a single mishap.

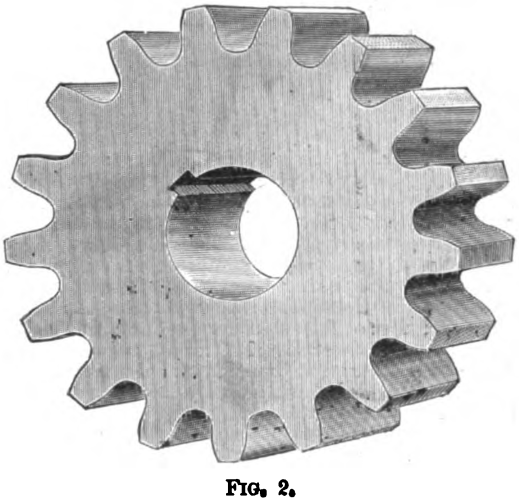


FIG. 2.

In addition to their use on electric cars, these gears are well adapted for other machinery, such as machine tools, etc., and several well-known tool builders such as Pratt & Whitney, of Hartford, use them in their work. These gears are not only remarkably durable in themselves, but it is claimed that the life of large iron gears is longer, used in connection with them, than when meshing with metal pinions.

THE BRISTOL RECORDING PRESSURE GAUGE.

The remark has often been made that the management of the coal pile determines whether money is made or lost in the operation of an electric light station. The coal being the original source of power, it is evident that anything to increase economy and to regulate its consumption must lead to a direct benefit to the management, and this is being recognized more and more by the introduction of coal saving devices. Given these, together with efficient engines, the results must prove satisfactory. But even with the best appliances, neglect on some points which require the exercise of intelligence may not develop the full value of the economizing apparatus, and among these the bad management of the boilers is a frequent source of loss. Careless and wasteful firing, accompanied by successive rise and fall of pressure, may vitiate all the benefits which would be otherwise derived, and hence a check upon the work of the fireman will tend to make complete the economy generally aimed at. For this purpose a recording steam gauge is now acknowledged to be an essential part of the equipment of the boiler room of an electric light station, so that a continuous record of the work of the firemen may be constantly before the eyes of the manager. At the recent meeting of the American Society of Mechanical Engineers, Prof. W. H. Bristol, of the Stevens Institute of Technology, described a very ingenious and simple recording pressure gauge which elicited the warm admiration of many present. The accompanying engraving, Fig. 1, shows the instrument complete, and Fig. 2 shows the pressure tube with the inking pointer attached, the front of the case, dial and cover of the clock being removed. As will be seen, the pressure tube, A, is of flattened cross-section and bent into approximately a sinusoidal form. A flexible strip, B, of the same metal as the tube is secured at the ends and along the bends. The bent tube may be considered as a series of Bourdon springs placed end to end. It is evident that pressure applied to the tube produces a tendency to straighten each bend, or collectively, to elongate the whole. This tendency to lengthen the tube is resisted by the flexible strip B, and is thereby converted into a multiplied lateral motion. The inking pointer is attached directly to the end of the pressure tube, as shown in Fig. 2, from which it will be seen that the usual mechanism and multiplying devices are dispensed with, since the motion of the tube itself is positive and of sufficient range. The special advantage of this is evident, considering that in the usual forms of pressure gauges the movement of the tube or diaphragm is small, and requires a somewhat complicated system of mechanism to multiply the motion many times before it is available for indicating purposes.

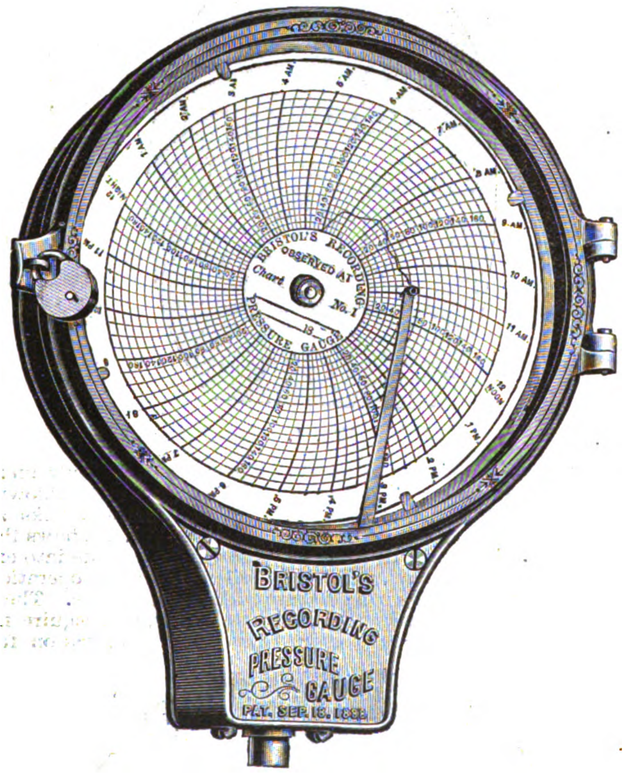


FIG. 1.

In the instrument illustrated the tube is designed for a range of 180 pounds per square inch; for other ranges its sensitiveness may be varied at will by changing its proportions, as length, shape of cross-section, or thickness. The printed charts for receiving the record make one revolution in twenty-four hours, and are provided with radial arcs and concentric circles, the divisions on the radial arcs corresponding to differences in pressure; while those on the concentric circles correspond to the hours of the day and night.

During the past year and a half several of the instruments have been in operation upon the steam boilers at the Stevens Institute and have given perfectly satisfactory results, and others are now in operation in a number of electric light stations. It is evident that the instrument is adapted for a vacuum as well as for a pressure gauge.

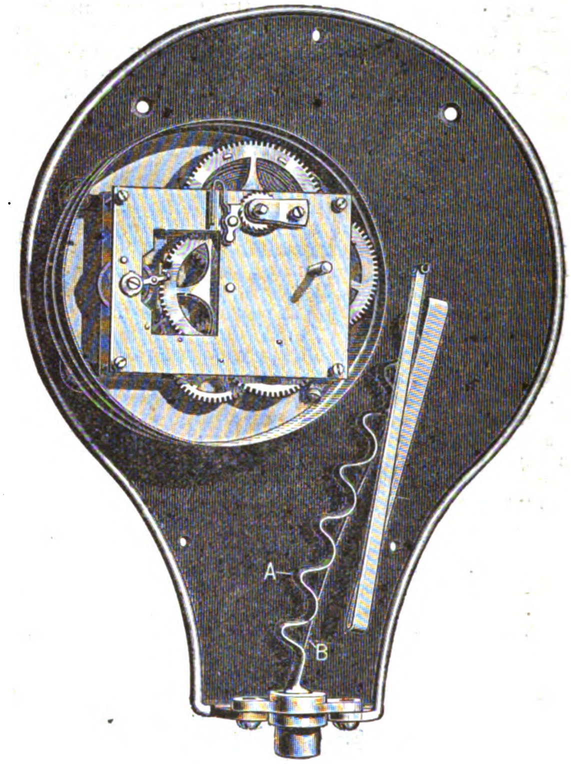


FIG. 2.

In the discussion which followed the description of Prof. Bristol's recording gauge, Mr. Chas. A. Hague pointed out that cases occur where boilers are left with banked fires during periods when not in use, but where it is desired to keep them in readiness to be used at short notice, or where it is desired for any reason to maintain a moderate steam pressure during the period of inactivity. When such boilers are left alone nobody really knows to what point the pressure at times has risen, and thus seemingly inexplicable accidents happen. The pressure is carried through the days perhaps at 80 pounds, and it is supposed to be run down and be kept say at 25 pounds all night. The fires are banked and the boilers are left to themselves, apparently in a safe condition. But with boilers set in brickwork the fire-brick lining of the setting gets pretty hot during the day, and forms, as it were, a reservoir of heat; and if the fireman is in a special hurry to get away, it very often happens that sufficient precaution has not been taken to prevent the rise of steam pressure during the night. Now, without a recording pressure gauge of some kind nobody could tell in the morning to what point pressure might have risen during the night, although in the morning it might be even lower than the regulation limit for the night time. With a record made by a gauge during the night, locked up in the superintendent's or the manager's office, and out of reach of the fireman, the unexpected and perhaps dangerous pressure to which a boiler might be subjected can be known and precautions taken accordingly. Mr. A. R. Wolff also called attention to the fact that the gauge was simple, could be easily constructed, and, consequently, placed upon the market at a moderate price—one which would make it possible for engineers to include a recording gauge in their specifications.

The instrument described above is manufactured by the Bristols' Manufacturing Company, of this city and Waterbury, Conn.

TRADE NOTES AND NOVELTIES.

AND MECHANICAL DEPARTMENT.

THE E. P. GLEASON MFG. CO.'S APPLIANCES.

For some few years past it has been the habit of the E. P. Gleason Mfg. Co., of 181-189 Mercer street, this city, to issue a catalogue of its electrical appliances. Last week it brought out the edition for 1890 in a manner evincing not only liberality and enterprise, but giving new evidence, if it were necessary, of the intention of the concern to repeat and excel in the electrical field the successes and triumphs that have distinguished it in the past, and through long years in the domain of gas lighting. This catalogue is a sumptuous large folio of 73 pages, bound in stiff stamped cover. One does not greatly envy the experts who had to prepare such a publication for press. It contains no fewer than 900 cuts, and of these over 400 are new, or have not before appeared in the catalogue. The title page gives views of the company's fine headquarters and warerooms in this city, and of its glass works in Brooklyn. The index counts up no fewer than 74 distinct headings, many of which have several subdivisions, and it is suggestive of the various improvements and evolutions that have been necessary to render the electric light safe and convenient. In fact, a very large part of the success of the electric light lies in the perfection of these details, including, for example, such things as lamp guards, insulating joints, sockets, shades, holders, switches, moldings, rosettes, brackets, etc.

Among the features that may be specially mentioned is the grouping of the gas and electric glassware for combination fixtures, so as to show exactly how such fixtures look when the globes for both kinds of light are placed on them. The globes shown are of very graceful and elegant pattern. We note also some new glassware called the "Stalactite," shown in bulbs and radiators, the shape been modeled after that of the stalactites that form slowly in the cavernous recesses of the earth. These stalactite globes are made up in rich cut, etched, crystal, flint, twist and spot opalescent glass, and bid fair to become extremely popular, having created a very favorable impression wherever seen. Another line of novelties we notice is that of suspended opal glass reflectors, with prisms. In the line of circuit details, we note some useful and ingenious new adjustable double-pole cut-outs, so made that the fuses are carried in the removable porcelain caps or covers. The pages devoted to insulating joints also show several excellent novelties.

Taken as a whole, the catalogue is the best publication of the kind we have seen for a long time past, and is one that should be in the hands of all intending purchasers of electrical appliances for arc and incandescent lighting or other electrical work.

LARGE CROWDS SUCCESSFULLY CARRIED IN CLEVELAND AND BUFFALO.

Decoration week clearly demonstrated the ability of the electric system of street car propulsion to take care of enormous loads. In the cities the amount of travel imposed upon the electric cars was far in excess of that for which they were intended, but in spite of the extraordinary crowds carried in each case, the operation of the cars was successful in every particular.

At Cleveland on May 30, occurred the ceremonies connected with the dedication of the Garfield Memorial, and the city was crowded with strangers, all of whom of course took the electric cars to the Park. The greater part of these people were carried by the Sprague electric cars on the East Cleveland Street Railway, though many passed over the line of the other two street railways in Cleveland. The cars on all three lines were crowded with passengers. Many of the cars ran trailers, and both motor car and trailer were taxed to their uttermost capacity.

In Buffalo, on the following Sunday, the four electric cars in operation on the Buffalo Street Railway ran all day long, drawing one or two trailers each, and they are credited with carrying in all over 15,000 passengers.

It is said and can readily be believed that the managers of the roads in both of these cities are very enthusiastic over the operation of the cars, and the press of the city has spoken in the highest terms of the performance under these most trying conditions.

CLEVERLY'S BLOTTING PADS.

H. A. CLEVERLY, of 1018 Chestnut street, Philadelphia, has made a new departure, and in addition to Perret motors, bells and annunciators, general electrical supplies, etc., is now handling blotting pads in large quantities. He is disposing of several car loads daily. He will no doubt find this branch of business enlarge, as they go for absolutely nothing. The quality of the pads is excellent, and they absorb ink as readily almost as Mr. Cleverly does business orders.

LIGHTING THE HOTEL ABERDEEN, NEW YORK.

An exhibition was given at the Hotel Aberdeen, on May 26, of Mr. J. H. Mason's primary battery work in electric lighting, fan propelling, etc. The plant consisted of one 25 c. p. lamp, three 6 c. p. lamps, and a fan driven by an ⅛ h. p. motor. Everyone was greatly pleased with the exhibit, and several orders for both fan and lights were the result. A large number of ladies and gentlemen were present, including Mr. A. Foster, the proprietor of the hotel.

THE TENNESSEE VOLTA ECLIPSE ELECTRIC COMPANY.

This company has been formed at Memphis, Tenn., to introduce the "Volta Eclipse" primary battery, invented by Mr. W. A. Crowdus, who is well known in the battery field. Connected with this company is the Volta Electrical Manufacturing and Supply Co. It is claimed that with this battery light and power can be furnished as cheaply as by dynamo. Mr. Crowdus says: "Recognizing the public's general opinion of primary batteries I have only to say that we make few claims but do much work." Of the first named company J. W. Allison is president; B. M. Stratton, vice-president; D. T. Porter, treasurer; T. S. Carman, manager; and W. A. Crowdus, electrical engineer. The company is beginning its work in Tennessee and adjoining States.

WOODHOUSE & RAWSON'S UNITED LIMITED EXHIBIT AT EDINBURGH.

Messrs. Woodhouse & Rawson United Limited have designed and carried out one of the prettiest lighting exhibits in the Electrical Exhibition now being held at Edinburgh, Scotland. It certainly presents at night a very attractive centre to the ornamental grounds of this exhibition. The band stand in question has been specially designed by Mr. Carter, the architect and engineer of the Exhibition. It is lit in rather a unique manner. In the centre of the sounding board is placed a Trotter diffuser with three lamps, and from this there are radial lines of 8 c. p. lamps, frosted in colored shades. Around the edge of the band stand are rows of small lamps and shades, while over the steps are placed in cut glass fittings two high c. p. lamps. Outside the stand on top are eight 100 c. p. incandescent lamps hanging from brackets and enclosed in cut glass fittings; lower down still are eight spikes, which are illuminated at their points by smaller lamps. The current is supplied from the central machinery hall by means of a pair of underground lead covered mains. The dynamo is of the Elwell Parker type, compound wound, 102 volts, and is driven off one of the large horizontal Robey engines. This machine also supplies the stall of Messrs. Woodhouse & Rawson, on which are shown Scott's electric flash signaling lantern for signaling by flashes according to the Morse alphabet; Barber Starkey's accumulator cut-out; Horn's electric tachometer; insulating material for switch bases; voltmeters, ammeters, lamps, telegraph instruments, bells, etc.

ADVANCE IN RUBBER GOODS.

A meeting of the Manufacturers of Mechanical Rubber Goods was held in this city May 27. The following manufacturers were represented and participated in the action taken:

New York Belting and Packing Company, New York; Boston Belting Company, Boston, Mass.; Gutta Percha and Rubber Mfg. Company, New York; New York Rubber Company, New York; Revere Rubber Company, Trenton, N. J.; Boston Woven Hose Company, Boston, Mass.; Brook, Oliphant & Co., New York; Trenton Rubber Company, Trenton, N. J.; New Jersey Car Spring and Rubber Company, Jersey City, N. J.; Hamilton Rubber Company, Trenton, N. J.; Home Rubber Company, Trenton, N. J.; B. F. Goodrich Company, New York; Whitehead Bros. Company, Trenton, N. J.; Star Rubber Company, Trenton, N. J., Erie Rubber Company, Erie; Pa.; Hartford Rubber Works Company, Hartford, Conn.; National India Rubber Company, Cleveland, Ohio; Mercer Rubber Company, Trenton, N. J.; Cleveland Rubber Company, Cleveland, Ohio; Chicago Rubber Company, Chicago, Ill.

In view of the advance in crude rubber it was unanimously decided to advance prices on rubber hose, belting and packing 10 per cent., such advance to go into effect June 2. This advance is regarded as conservative and justifiable and the market is characterized by firmness and strength.

THE BRUSH AND SHORT SYSTEMS.

The Brush Electric Company and the Short Electric Railway Co. of Cleveland, have put in the hands of their traveling agents and representatives an extremely neat and effective business card. On one side is a view of the magnificent Brush works at Cleveland, and on the other is a cut of the Short electric car, in full operation, on the overhead system. Both engravings, though small, are very clear and pretty, and the card cannot fail to make a most favorable impression on any one seeing or receiving it.

THE EDISON UNITED MANUFACTURING COMPANY.

There has never been a superabundance of Edison lighting literature. On the contrary, we have often thought that the Edison Company suffered from its lack in this respect, since in these days it hardly pays any electrical concern to "hide its light under a bushel." We are glad to see that the want is now being supplied by the United Edison Manufacturing Company, which has just issued a very handsome pamphlet, for a copy of which we are indebted to the energetic general manager, Mr. H. Ward Leonard. The pamphlet is an oblong folio of 71 pages, the covers of cream white flexible card. The front cover is richly embossed in gold with the name of the company and with a large cut of the standard Edison dynamo. The back cover is not embossed but is printed in blue, gray and gold, with a full size Edison lamp and socket. The whole is tied together with lavender silk cord.

As a frontispiece, appears a fine view of the Edison Machine Works at Schenectady.

This is followed by an excellent brief description of the Edison system, a list of the details of a plant, an engraving of the Edison machine, and a table showing the sizes, speeds, weights, voltage and amperage of the different types, from 5 lamps up to 2,500 lamps capacity. A short description is given of the machine itself, and this is followed up by an illustrated description of the meters, lamps, sockets, switches, etc. This section is followed by one in which are comprised a larger number of replies to a series of questions addressed to purchasers and users of the Edison system, whether in central stations or isolated plants. It is a really magnificent exhibit for a company to make, and embodies not a little interesting and suggestive information. Succeeding this part, come the "standard specifications for electrical plants," and last of all is given a synopsis of the patent and legal points on which the Edison system bases its claims to the practical control of incandescent lighting in this country.

UTICA, N. Y., ELECTRIC RAILWAY.

The work on the electrical equipment of the Utica & Mohawk Electric Railway at Utica, N. Y., is being carried forward as rapidly as possible, and it will not be long before the cars will be ready for operation. The motors and line equipment have already been shipped, and the final shipment of station equipment is expected to be made in a few days. Each car will be equipped with two 15 h. p. Sprague improved electric motors with all the latest improvements and devices used upon any of the Sprague roads.

SAWYER-MAN LAMP FACTORY.

The large factory of the Sawyer-Man Co. at 510-534 West Twenty-third street, has again been undergoing enlargement, and in spite of the fact that the summer months are generally supposed to be those when light becomes a secondary consideration, the factory, Mr. P. H. Alexander says, will not be able to keep pace with its orders and the new business until the extensions and improvements are all available. The buildings when fully equipped will have a capacity of 15,000 lamps a day.

EXTENSION OF WESTINGHOUSE PLANTS.

The town of Oregon in the State of Illinois is determined not to be behind its sister towns in the matter of illumination. A company has recently been formed in Oregon, to go into the electric lighting business and the new corporation has placed an order with the Westinghouse Electric Company, for one of that company's 500 light alternate current incandescent dynamos. No time will be lost in the construction of the plant.

Moundsville, W. Va., will have an electric light plant. The Westinghouse Electric Company is about to ship to Moundsville, one of its five hundred light alternate current incandescent dynamos to fill a recently received order from a new lighting company there.

The Apollo Iron and Steel Company of Apollo, Pa., has decided to illuminate its works by electricity. The company has been prompted to make this improvement on account of the great increase in its business, which necessitates working at night. The new arc lighting system of the Westinghouse Electric Company, will be used in lighting the plant.

THE RICE AUTOMATIC ENGINE.

The John T. Noye Mfg. Co., of Buffalo, N. Y., have recently issued some new literature illustrative and descriptive of their well-known Rice Automatic Engine, which is now in extensive use in the electric lighting field. It is a "self-contained side crank" engine, and in this form is to be found in a great many stations. Of late the call has also been heard for compound, and compound condensing engines, and these the company is now supplying in the larger sizes. One of the pamphlets contains details of the various types; another gives a striking array of testimonials from users, dating down to the beginning of the present year.

THE NATIONAL ELECTRIC DEVELOPMENT COMPANY.

A company called the National Electric Development Company has been organized in San Francisco, to act as a branch of the National Electric Manufacturing Co., of Eau Claire, Wis. The last named company is fortunate in being under the management of Mr. G. B. Shaw, ex-mayor of Eau Claire, through whose direction and energy it is now doing a rushing business with its lighting and power apparatus. One of the staff of THE ELECTRICAL ENGINEER had the pleasure recently of visiting its factory, and was surprised at the great activity and the abounding signs of prosperity under a vigilant and capable management.

THE ST. LOUIS ELECTRICAL EXHIBITION.

MR. F. H. WHIPPLE is now in this city, having taken possession of his new offices in the Temple Court building, Beekman street. He is devoting his energies just now to work on the second annual electrical exhibition at St. Louis, which will last from September 3 to October 18. He is already in receipt of a large number of applications, and spaces will be alloted August 1. No charge whatever is made for space or power, and this fact coupled with the advantages of St. Louis as a distributing centre, will doubtless induce electrical concerns all over the country to make a large and creditable display. A great many novelties are expected.

PAGET & KINTNER.

The firm of Paget & Kintner, chemical and electrical experts and electrical engineers, of 45 Broadway, has been dissolved. Mr. C. J. Kintner will continue the business as successor at the old address.

WESTERN WORK OF THE THOMSON-HOUSTON COMPANY.

The Thomson-Houston Electric Co., through its general agent, Mr. Theo. P. Bailey, at Chicago, reports the following new business during the past month in the railway department: Missouri Railroad Co., St. Louis, Mo., 36 motor cars; Mound City Railroad Co., St. Louis, Mo., 25 motor cars; the Wichita Electric Railway Co., Wichita, Kan., 20 motor cars; Rockford City Railway Co., Rockford, Ill., 3 motor cars (increase); Jacob Rich, San Jose, Cal., 5 motor cars.

The Union Depot Street Railroad Co., St. Louis, Mo., equipped with 30 Thomson-Houston motor cars, was formally opened for business over the entire length of the road, extending from the heart of the city seven miles out in suburban territory, and we are informed the opening was a grand success.

The list of sales of Chicago office of the Thomson-Houston Electric Co. for the month of May is as follows:

Arc.—New Omaha Thomson-Houston E. Co., Omaha, Neb., 50 lights; Cheboygan, Mich., Lumber Co., 9 lights; Battle Creek, Mich., El. Light Co., 35 lights; Jas. P. Anderson, Trenton, Mo., 30 lights; Joliet, Ill., Wheel Co., 3 lights; Armour & Co., Chicago, Ill., 105 lights; Kalamazoo, Mich., Elec. Co., 50 lights; California Theatre and Hotel Building, San Francisco, Cal., 20 lights; Hammond, Ind., Milling Co., 50 lights; Salt Lake Power, Lt. and Htg. Co., Salt Lake City, Utah, 30 lights; Decatur, Ill., Gas Lt. and Coke Co., 50 lights; Edison Light Co., Grand Rapids, Mich., 50 lights; Denver, Col., Elec. Illuminating Co., 70 lights; So. Western Elec. Lt. and Water Pr. Co., Joplin, Mo., 100 lights.

Direct Incandescent.—G. F. & E. A. Burkhart, Chicago, Ill., 85 lights; Chas. Hebard & Son, Pequaming, Mich., 150 lights; Gratwick, Smith & Fryer Lumber Co., Oscoda, Mich., 350 lights; Excelsior Elec. Co., Port Huron, Mich., 20 lights; Osage Coal and Mining Co., McAlester, Ind. Ter., 300 lights.

Alternating Incandescent.—Central El. Lt. and Pr. Co., Sedalia, Mo., 650 lights; Jas. P. Anderson, Trenton, Mo., 650 lights; Moffett, Hodgkins & Clark, LaGrange, Ill., 650 lights; Kalamazoo, Mich., Elec. Co., 650 lights; H. M. Loud & Sons, Oscoda, Mich., 300 lights; Redding, Cal., Water Co., 650 lights; Highland Park, Ill., El. Lt. Co., 650 lights.

Motors.—S. E. Hopewell, Omaha, Neb., 2; A. H. Revell & Co., Chicago, Ill., 1; Western Thorn Type Setting Co., Chicago, Ill., 1.

BLISS & ANGELL.

Mr. Geo. H. Bliss, electrical expert, 225 Dearborn street, Chicago, has now associated with him as partner Mr. Jos. Angell (his former partner, Dr. Louis Bell having severed his connection) under the firm name of Bliss & Angell. Both gentlemen are to be congratulated upon this new connection. Mr. Angell is a man of noted ability in expert electrical work, being thoroughly well versed in all its branches, and further is highly appreciated by all his acquaintances. He has had a wide field of experience in the South in electrical and engineering matters in organizing and carrying out electric light and water works systems and plants. Mr. Bliss, so well and favorably known amongst the electrical fraternity, is paying especial attention to electrical investment business, dealing in electrical securities. Investors contemplating business of this kind should certainly give him a call.

THE ELECTRIC MERCHANDISE COMPANY.

The merchandise business of the Sprague Electric Equipment Company, Rialto Building, Chicago, has been purchased by a new corporation called the Electric Merchandise Company, whose offices hereafter will be at No. 11 Adams street, opposite the Pullman Building. This company in addition to continuing the merchandise business of the old company, will also manufacture and sell electric railway appliances for station, car and line work, of all kinds *irrespective of system*. Their experience in the Equipment Company has been such that they are peculiarly well fitted to recommend material which has been found by practical use to be the most satisfactory. Such connections have been made with Eastern manufacturers that in most cases goods can be bought at the same prices of the Merchandise Company as direct from the factory, time and frieght being saved, as all goods will be carried in stock. Catalogues will be furnished on application. Mr. W. R. Mason, so well known as the former general sales agent of the Sprague Electric Equipment Co., has been appointed general manager. In such hands, the business of the company will assuredly prosper, more especially as Mr. Mason and his staff will give great attention to the perfecting of details, which will lead to numerous and advantageous improvements in electric street railway work and equipment.

THOMSON-HOUSTON ELECTRIC RAILWAY WORK.

The Thomson-Houston Electric Co. opened their electric railway plant for public business at Salem, O., last week, and the local papers in expressing the sentiment of the people state that it is the grandest improvement which has yet favored their city.

The Thomson-Houston electric railway plant at Indianapolis, Ind., was to be opened to the public last week. The installation consists of 10 motor cars, to be operated over 6 miles of double track, the first 4 miles of which, leading out from the heart of the city, is equipped on the centre-pole method of overhead construction, with an ornamental iron pole in the centre of the street between the tracks. This is reported as being the most elaborately equipped road in the country. The new cars are the finest that could be constructed.

NEW YORK TRADE NOTES.

The Globe Fan Co. of 368 Broadway have a very pretty display of their fans, in their windows at the above address, one fan being run by a Crocker-Wheeler motor, and the wind from it drives several immediately under, showing the force of wind obtained.

Mr. P. B. Delany has lately removed to New Jersey, and is now building experimental works at South Orange. With his new facilities he may be expected to do a great deal of excellent work.

Mr. Emil Gabel, the eastern representative of the Ch. Munson Belting Co., of Chicago, has just taken an order for 119 feet of 48-inch three ply belting to be placed in the Philadelphia Illuminating Co.'s station, of which Mr. A. J. De Camp is the general manager.

NEW ENGLAND TRADE NOTES.

Wainwright Manufacturing Company, of Massachusetts, owing to their largely increasing business, have changed their offices from 34 Oliver street to more commodious and convenient offices on the second floor of the Vulcan Building, 8 Oliver street, Boston.

The Thomson-Houston Motor Company, have just published a most interesting little pamphlet entitled "The Thomson-Houston Motor," in which will be found a vast amount of useful information regarding the construction, utility, horse-power, necessary belt speed, floor space and dimensions of their electric motors. The pamphlet is handsomely got up, and contains an excellent cut of the motor.

The Gould & Watson Company.—No better exponent of the development of electric street railways can be given than the large orders received by the Gould & Watson Co., Boston, for their Molded Mica Insulators, which in the past week amounted to the remarkable sum of 50,000 pieces for line work alone. Further endorsement of the excellence of these insulators is not needed. This house furnishes by far the major part of the line insulators used in this country, and also does a considerable foreign business.

The New England Electric Company, agents for the Sprague system, have secured the contract for equipping the Manet Street Railway Company, of Quincy, Mass. This road will extend from Quincy to Howe's Neck, a distance of 3½ miles, and will be single track. There will be two motor cars of 30 h. p. each, and two tow cars. Mr. George F. Steele, is now president of the company, and Mr. Edward Blake, treasurer. The latter gentleman is soon expected back in Boston, having become convalescent from his protracted illness.

Mr. D. A. Andrews, Jr., of the firm of Pettingell, Andrews & Co., has started on a trip through the West, and will doubtless visit all the large cities. The business of this firm continues to increase in the most amazing manner, and the amount of business done for the past quarter is almost double the business done during the corresponding period last year. Messrs. Pettingell, Andrews & Company, have gone into the manufacturing of cut-outs, and general electric supplies, and are keeping a large pottery busy supplying them with porcelains. They will soon have on the market a complete line of porcelain cut-outs, fuse-boxes, rosettes, etc.

The Inter-Continental Telephone Company have received through Kidder, Peabody & Company the £35,000 from the Venezuela and Electrical Appliance Company, limited, for the sale of their rights in Venezuela to that company. The Tropical American Telephone Company having absorbed the Inter-Continental Company, get the lion's share of this sum. The Venezuela and Electrical Company have sent out about $25,000 of telephonic apparatus, and have placed orders since May 1st with the Tropical Company, the sole exporters of telephonic apparatus to South and Central America and West Indies, for telephonic apparatus amounting to $25,000.

The Electric Gas Lighting Company.—Mr. W. W. Burnham, of this company, is at present making an extended trip in Illinois and the West, and has recently secured a number of large orders for Samson batteries, among them being two orders for 1,000 batteries each. The Samson battery appears to be growing more popular than ever, an honest trial by customers never failing to result in more business and successive orders. The Electric Gas Lighting Company have just received 10,000 carbons from Paris, and there are 10,000 more on the way. The battery is well named "Samson."

The Brown Electric Protector Company of New England has been organized under the laws of the State of New Jersey with a capital of $50,000, for the manufacture and sale of the Brown electric protector. The officers of the company are as follows: William H. Smith, president and general manager; Robert Johnston, treasurer; Dustin Killicutt, secretary; directors, S. E. Barton, C. E. Bibber, Joseph H. Reall, William T. Brown, and the three officers of the company as above. All the gentlemen are well known in electrical circles, Mr. Smith being superintendent of the Mutual District Telegraph Company; Mr. Johnston, general manager of the Johnston Heater Company, and Mr. Killicutt being connected with the Simplex Electric Company. The protector is meeting with great success, and arrangements are now being made for their manufacture on a large scale.

Mr. Eugene F. Phillips, of the American Electrical Works, Providence, gave a very enjoyable clam dinner to Mr. and Mrs. John I. Sabin and daughter, of San Francisco, on June 4th, at the Ponham Club, Providence River. A special steamer was provided for the accommodation of the party, consisting of Mr. and Mrs. Eugene F. Phillips, Mr. and Mrs. W. A. Sawyer, Col. and Mrs. Keeler, Mr. and Mrs. E. B. Baker, of New Haven, Mr. and Mrs. F. E. Pettingell, of Boston, Mayor Henry F. Barker, of Providence, Mr. Henry Barker, Miss Jessie Barker, Miss Lincoln, Mrs. Hoxie, Mr. Thomas Doolittle, Mr. P. C. Ackerman, of New York, Mr. E. A. Smith, Mr. A. C. White, Mr. E. P. Phillips, Mr. F. M. Phillips, and Mr. C. Waggensein. Games of foot-ball were indulged in by the ladies and gentlemen, and the bowling alley was also well patronized. The dinner was served up in Mr. Phillips' usual magnificent manner, and enjoyed by all, who agreed that they had had a glorious time, and that Mr. Phillips was a king among hosts.

John Becker & Company, of 157 Pearl street, Boston, are manufacturers of name plates for almost every electric company. They have a large and compact brass foundry on the fourth floor of their building, and are constantly turning out new designs of name plates. The machine shop is fitted with every conceivable kind of machine, and Mr. Becker does not require to go outside of his shop for any part of the work. The steel engraving of the original plates is extremely interesting and is largely done by specially designed milling machines, which run at an extraordinarily high speed. The plates are bronzed or nickel-plated, as desired, and are turned out with a very superior finish. Mr. Becker has also a quantity of fine electric work in hand, and has a shop well adapted for the finest kind of work. This is evidently a growing business, and there is undoubtedly a large field for such work, where electricians can have their ideas carried out under the superintendence of a thoroughly mechanical expert.

Kendall & Slade are at present engaged on a very complete electric installation in a private residence on Beacon street, Boston. The house will be wired throughout for electric light—Edison system—electric bells, electric burglar alarm, electric gas lighting apparatus, speaking tubes, and also for motors. In the halls all the electric lights will be on separate fixtures from the gas lights. Automatic heater regulators will be put in throughout, and there will be motors for sewing machines, ventilating fan and passenger elevator. The current will be taken from the Edison tubes, and the whole job when completed will be one of the most complete in the city, the proprietor being determined to utilize electricity wherever possible. Kendall & Slade are also busy with supplies at present, and are making a specialty of cedar poles, which they furnish in great quantities and at very short notice. Among the cities which they have recently supplied with poles are Revere, Gloucester, Swampscott, Malden, New Bedford, Fitchburg and Dover.

WESTERN TRADE NOTES.

The Universal Radial Drill Co. have issued a very neat and tasteful calendar sheet for June. The front shows their foot lever countersinker or post drill, and on the other side are some descriptive details and a view of their works at Cincinnati.

Mr. Rose, of the Rose Electric Light Supply Company, 1106 Pine street, St. Louis, Mo., was in town this week. He reports business as booming and says he is selling a remarkably large number of second-hand machines and appliances. He expects to return to St. Louis in a day or two. Mr. Rose is a pusher and has worked up his large business by means of his energy and sterling business qualities.

Mr. George Cutter has issued to his many friends and patrons the following removal announcement: Removal—Mr. Geo. Cutter wishes to announce to his many patrons that he has transferred his stock of electrical supplies from 80 Adams street to 190 & 192 *Fifth avenue*, between Adams and Monroe streets, where he will be succeeded by the Great Western Electric Supply Company. He has now better facilities than ever for supplying the demands upon him and solicits a continuance of patronage.

Keelyn & Vandenburg is the title of a new firm just started for the purpose of establishing, buying and selling electric lighting, water works and power plants, with fine offices located at No. 185 Dearborn street, Chicago. The company is well backed financially, and parties contemplating business of this class may rest assured that it would be impossible to place it in better hands, as the above named gentlemen are well and widely known for their extended experience and ability in such matters, and all work they may undertake will be carried out in the best manner possible.

The Ft. Wayne Electric Company, 185 Dearborn street, have just completed the installation of a "New Wood" arc plant and a direct current incandescent plant for the Pennsylvania Railway Company's department in Chicago, which is spoken of in the very highest terms of praise by all those who have seen it. The plant is also utilized for charging the storage batteries used by the company, and is remarkably complete in all its various details. It is giving the greatest satisfaction right along. Mr. J. E. Keelyn, of the Ft. Wayne Electric Company, has closed a contract for an arc and incandescent plant for Lockport, Ill.

The Electrical Supply Company are as usual pushing ahead all the time. They are selling large quantities of Habirshaw wire, which has a great reputation for its durable qualities for interior work of all kinds in plaster and damp places. The Interior Conduits, for which they are the western agents, are meeting with enormous success and universal adoption. This is the one system needed to make interior wiring in buildings absolutely safe and to facilitate repairs of any kind; and it thoroughly fills the bill by rendering all the wires accessible at any time in the simplest possible manner. They are doing quite a brisk trade in their other specialties and supplies of all kinds.

Foree Bain has just received an order for four dynamos of 80 h. p. each, of his new pattern dynamo, illustrated in The Electrical Engineer of May 28th, several of which are in operation and giving the greatest satisfaction all around. There are numerous points electrically and mechanically about the machine which immediately recommended it, and the fact of its being designed by such a well known authority in electrical matters as Mr. Bain is a criterion that nothing will be left undone to produce a machine of the highest possible efficiency and finest workmanship throughout. These machines are to be employed in mining work, and certainly the field in this direction is one of the largest.

The Ft. Wayne Electric Company, of Ft. Wayne, Ind., have just issued a very handsome and tastefully gotten up catalogue of their Slattery induction system of incandescent lighting and their Wood arc system. It is beautifully illustrated throughout with cuts of the Slattery alternating current machine and exciter, the transformer, measuring and station instruments, switches, safety devices and lightning arresters of that system. The new Wood arc system is amply pictured, too, including the Wood dynamo, brush gauge, arc lamp, hanger boards, focusing lamps, electric headlight and central station switchboard. The descriptive matter is full of information, containing many points of interest, and is remarkably clear, setting forth very prominently the advantages belonging to the apparatus of the company.

The Knapp Electrical Works, Chicago, notwithstanding their recent disastrous fire, are now in good shape again, and have continued filling their large orders right along. Their Grimshaw wire is always in large demand, as its excellence and durability are thoroughly appreciated by all who have ever used it. They have just shipped one order of $6,000 worth of wire to Denver Col., and other orders of all sizes are coming in all the time. In their Perkins incandescent lamps they are also doing a large business and one which is continually increasing as the efficiency and durability of their lamps become more and more widely recognized all over the country. Mr. Knapp is feeling very pleased with the business he is doing and very hopeful with regard to the future. He pushes everything he takes hold of to its fullest extent and is a pretty hard man for his competitors to get ahead of.

SCHIEREN BELTING FOR ELECTRIC PLANTS.

C. A. Schieren & Co., of Ferry street, this city, are enjoying an enormous trade in their belting and specialties, and are pushing for more. They have not only continued to add to the long list of central stations in which their belts are used, but they have struck out with immense success into the newer field of electric railroading, where they have already found a large number of customers. The prospects are that they will not be able to enjoy much leisure this summer, but will have to put forth their utmost energy to keep pace with the trade they have worked up and are developing. Young Mr. Schieren reports some recent excellent work among electric railways in this part of the country.

W. H. LAHMAN'S SPECIALTIES.

W. H. Lahman, 156 Lake street, Chicago, patentee and sole manufacturer of the Lahman-Kirkwood fuel saving and dumping grate bars, reports his business good, and the prospect for the summer and fall trade as very encouraging. The local demand in Chicago has been somewhat checked by the prevailing strikes, which have affected all the building trades. These, however, are nearly ended, and a very brisk business may be confidently looked for during the remainder of the year. The managers of several large plants who have been experimenting with oil as fuel have announced their intention of returning to coal, and consequently to grate bars. We have been furnished by Mr. Lahman with the following partial list of the orders recently secured by him, including only those of thirty square feet and upwards: Barracks, Fort Riley, Kan., 150 ft.; Water Works, Town of Lake, Ills., 146 ft.; Water Works, Hyde Park, Ills., 121., ft.; Water Works, Jackson, Mich., 50 ft.; Water Works, Great Falls, Mon., 53 ft.; Fessenden Building, Chicago, 90 ft.; Commercial Bank Building, Chicago, 50 ft.; Fairbank Building, Chicago, 131 ft.; Graham School, Chicago, 44 ft.; Erie Flats, Chicago, 35 ft.; Pitkin & Brooks, Chicago, 30 ft.; Hammond Building, Detroit, Mich., 87 ft.; New York Life Building, Kansas City, Mo., 68 ft.; Post Office, St. Joseph, Mo., 55 ft.; M. E. Herbert & Son, St. Joseph, Mo., 60 ft.; W. Kirkup & Son, Cincinnati, O., 48 ft.; Carter White Lead Co., Omaha, Neb., 39 ft.; Gas & Electric Light Co., Steubenville, O., 30 ft.; Pure Ice & Cold Storage Co., Springfield, Ills., 30 ft., etc. Mr. Lahman will soon issue his annual illustrated circular, showing his recent improvements, with hundreds of additional references to his already extended printed list. He will be pleased, also, to give intending purchasers desiring the same special references to any description of plant or where different kinds of coal are used. Mr. Lahman is represented in Kansas City., Mo., by Messrs. English, Morse & Co.

THE RELIANCE GAUGE COMPANY.

The Reliance Gauge Company, of Cleveland, O., report a wonderful increase in the demand for their specialty, the "Reliance" safety water column, and have booked recent orders from the following: W. P. Pollock & Co., Youngstown, O.; Canton Electric Light Co., Canton, O.; Chandler & Taylor Co., Indianapolis, Ind.; Morgan Engineering Co., Alliance, O.; Murphy Iron Works, Detroit, Mich.; Wheeler Furnace Co., Sharon, Pa.; John T. Caulfield, Richmond, Ind.; Laidlaw & Dunn Co., Cincinnati, O.; Mutual Electric Light Co., Alliance, O.; Graves & Marshall, Dayton, O.; Standard Oil Co., Whiting, Ind., Cleveland, O., and Olean, N. Y.; National Tube Works, McKeesport, Pa.; Phœnix Iron Works, Meadville, Pa.; Lansing Iron and Engine Works, Lansing, Mich.; E. Keeler Co., Williamsport, Pa.; Atha Tool Co., Newark, N. J.; C. Stewart & Son, Worcester, Mass.; Cyclops Steel Works, Titusville, Pa.; Grainger & Co., Louisville, Ky.; Casey Boiler Manufacturing Co., Chattanooga, Tenn.; Forbes, Liddell & Co., Montgomery, Ala., and numerous small orders from all sections of the country. Another specialty is now being made by this company in the line of floats of all sizes for high pressure work, and they have recently made some 12-inch ones for the United States government which have to stand an external pressure of 175 pounds per square inch. They claim to be able to make floats capable of withstanding any required pressure on the same principle as the floats used in the "Reliance" safety water columns.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada.	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. IX. NEW YORK, JUNE 18, 1890. No. 111

Our varying hypotheses are simply the confession of our ignorance in a hidden form; and so it ought to be, only the ignorance should be openly acknowledged.—Faraday.

DAYTIME WORK FOR CENTRAL STATIONS.

NOT less deeply seated than it is erroneous is the old idea that a central station business is one limited to the hours of darkness, and that a plant can only be made productive and dividend paying by means of its nocturnal activity. Five years ago, in the meetings of the National Electric Light Association, the central station managers and superintendents of the country began discussing the possibilities of the motor field. To-day many of them are still in the discussion stage, and others whose companies have "Light and Power" in their corporate titles have done absolutely nothing.

Yet there are bright and shining examples of success in the endeavor to make a given district yield its utmost of revenue from electric power. One instance we have in mind is that of Mr. E. B. Greene at Altoona. This energetic young superintendent, in a town of about 35,000 inhabitants, now has in operation about 80 motors, ranging in size from an eighth up to 40 h. p. These motors take 70 horse-power of current, and he has just contracted for about 50 horse-power more. All these motors are on the incandescent circuit, and their returns are not the least important part of an income yielding a dividend that now crosses the 8 per cent. line, and has warranted a large extension of the plant.

Rochester, in this state, furnishes a good example of arc motor service. There the veteran Mr. G. A. Redman has no fewer than 508 motors running in a city of about 125,000 inhabitants. He maintains three distinct power circuits, but also has motors intercalated among arc lamps and series incandescents. These motors range from an eighth up to 15 h. p., and the higher limit will soon be 25 and 30 horse-power.

In both the instances mentioned above, the rates are moderate and the new business is judiciously worked up and encouraged. Mr. Greene, while running a planing mill with 40 horse-power, has found time to develop the ingenious notion of putting in a small motor to keep dry a vault where books are stored. Mr. Redman furnishes electric power to no fewer than 108 tailor shops, and he is proud of the fact that in one of the Catholic institutions the motor is wholly taken care of by the sisters. One of his motors keeps dry a cellar on the plan of starting the pump motor by a float that lifts as the water collects in a barrel. In another case the motor drives a blower at the soldering bench in a tinware factory.

These are among the brighter examples of the day, and we could only wish there were more of them. Still, the good work has begun and is becoming so varied that not only are a large number of stations on an earning basis the day and night around, but the year through. Of course the larger cities will generally be the best places for electric power distribution and will see a steady displacement of other power transmission machinery by the electric motor; but nearly every town large enough to maintain an ordinary arc or incandescent or combination plant is also large enough to keep a generator or two going during the hours of daylight. We hope more of our readers will not delay in giving the new industry a fair trial.

ELECTRICITY IN AGRICULTURE.

THE earlier experiments on the effect of electricity upon plant growth were attended with rather contradictory results, but we publish this week reports of later and extended trials in Russia, under official auspices, that are remarkably encouraging and must carry conviction. The article we print from Mr. Specnew details the various experiments with battery current, and shows that some of these at the Kief Botanical Gardens brought out the influence of the current in larger crops and the growth of enormous vegetables. The most successful trials, however, were those made in the government of Pskow, and as the averages obtained are those of five years, it will be seen that no hasty conclusions have been arrived at. In this series static instead of current electricity was employed. The general results were that the yield in seed and straw was greatly increased. Ripening was quicker and there was less tendency to disease. Potatoes, instead of being 10 to 40 per cent. bad, were only 0 to 5 per cent. It is noteworthy that the charge was collected from the atmosphere by means of rods bearing light crowns which were all united by means of wires. It is not mentioned, but we should imagine that such a system would not only be effective in combating the disease germs underground but in "scare-crowing" the ravagers overhead.

Evidently this is work that needs following up, and we would like to suggest that the Agricultural Department at Cornell University give the matter its attention. If by such simple means phylloxera and potato bug and army worm can be fought off, while the crops themselves can be increased without fertilizers, it is time that a great agricultural country like ours knew more about it and acted on the information.

SYNCHRONOUS TELEGRAPHY.

For more than a quarter of a century, synchronous telegraphy has occupied the attention of inventors, and from the early attempts of the Nestor of American electricians, Moses G. Farmer, down through the work of Meyer, La Cour, Delany and others, we have seen many beautiful applications to enable a number of operators to employ the same wire simultaneously. The synchronous action of two alternating machines coupled together, though observed many years ago, has, however, only recently been applied in telegraphy in order to obtain synchronism ; but it now seems destined to a wide application in this field. The latest and most improved method for this purpose is described on another page, and embodies the results of an immense amount of work and experiment on the part of Lieut. F. Jarvis Patten. As pointed out elsewhere, one of the chief advantages secured by the use of the alternating motor is the fact that it remains in synchronism by preference, and, indeed, of necessity, and from the experiments which we have witnessed we may say that it requires considerable effort to throw it out of unison. While it remains to be seen over what length of circuit exceeding one hundred miles the system can be operated without intermediate repeating stations, enough has been demonstrated to prove that for such distances sextuplex working is perfectly feasible. With repeating stations at suitable intervals and branches connected to the same synchronizing circuit, we can imagine an entire network of lines and instruments operated with the distributing brushes from Maine to California kept on the same segments by the impulses emanating from New York.

Demonstrating Specific Inductive Capacity.

Although the influence of the varying specific inductive capacity of different bodies plays such an important part in electrical work, it may be safely said that there are but few even among those whose work involves directly the consideration of this phenomenon, who have had occasion to witness an ocular demonstration of its effects. Indeed, to the majority of electricians, and to students especially, dielectric capacity is largely an abstraction, due to the fact that unlike other electrical phenomena, its demonstration in a clear manner has been lacking, owing to the want of the proper apparatus. The description of a simple method of exhibiting the phenomena involved in the action of dielectrics under the influence of a charge is therefore eminently timely, and in that given on another page Prof. Mayer again shows the great resources at his command as an original experimenter. Demonstrations of this nature go far towards the fixing of ideas, and the members of the New York Electrical Society, who, some time ago had the privilege of witnessing them, were unanimous in their expression of praise and delight.

Volcanoes in Cities.

During the past week New York City has been treated to the remarkable spectacles of Broadway, its main thoroughfare, belching fire and smoke and gas day after day. By a series of mishaps, repairs in the steam heating mains led to a rupture of the gas mains, and the ignition of the gas caused explosions in the electric subways and blew up the Fulton street manhole, as well as destroyed the cables passing through it. The blame for this state of affairs, which is at once dangerous and exasperating, has still to be fixed ; but wherever it lies it is safe to say that these explosions will go on, and that the electrical people will suffer. Such events are interpreted by many observers as meaning that the only or best solution of the subway problem for main streets networked with pipes is a large, well ventilated tunnel. We believe a tunnel will be built sooner or later.

Electric Traction Data.

At first very meagre, the data on electric traction is rapidly increasing, so that even now we are in possession of such information as will enable the engineer to predicate results with tolerable accuracy. This, however, is true more particularly of railways in which the overhead conductor in employed, and the many roads in operation in this country to-day afford ample facilities for observation and study. Up to the present time, however, there has been a great dearth of information on storage battery traction, which, though occupying a less prominent position at the present time, must in the nature of things assume prominence and obtain recognition in the future. Some time ago Mr. Anthony Reckenzaun visited this country in the interest of parties developing storag ebattery traction, and we are now placed in possession of some of the results obtained by him. His paper, read before the Old Students' Association, is replete with valuable facts and suggestions.

The Cost of a Municipal Plant.

It is interesting to note that the estimate furnished to the Common Council of Milwaukee, Wis., of the cost of a municipal lighting plant reaches the respectable figure of nearly $600,000. The raising of such a sum of money and the interest on it by taxation is hardly likely, one would think, to recommend itself to the citizens, when they are able to contract for all the lights they want, at a certain rate, and there end any responsibility or burden, as well as avoid the increase in the number of "mercenaries" that would follow the creation of a new city department under political control.

A Wiring Calculator.

Dr. Holmes once gave expression to the sentiment that mathematicians were not entitled to high consideration, in view of the fact that most of their work could be performed by the calculating machine, or the "calculating hand-organ," as he terms it. While this was evidently playful, and not meant to be taken literally, there is much truth in the idea when applied to ready methods of obtaining results by persons not capable of "handling figures" quickly. The calculation of the size of wires to carry currents with safety and with a given drop is one of the most frequently recurring in electrical work, and a handy calculator, such as that described elsewhere, will go far towards removing the doubt and anxiety of the wireman as to the correctness of his work. We are glad to welcome such appliances.

The Executive Committee of the National Electric Light Association met on June 16, and among other matters fixed August 19 as the date for the Cape May Convention.

PATTEN'S IMPROVED MULTIPLEX TELEGRAPH.

We are enabled to give in this issue a brief description of the Patten system of multiplex telegraphy as it is operated to-day on wires between New York and Philadelphia. As is probably known to our readers, it is a system of the synchronous multiplex type, depending for its operation upon the synchronous and uniform movement of two or more electric motors placed at distant points. In the present instance this is achieved by a novel application of the peculiar properties of electric motors, and the synchronism, far from being delicate, is powerful and reliable. The machine may evidently be of any size and power, and there is an evident tendency to run into synchronism instead of running out, which latter has been the case in former attempts at unison movements based upon the isochronous movement of a single machine. It is evident that an ordinary Siemens armature in a two pole field must reverse its current at every half revolution. If by any means two such machines be caused to reverse their armature currents simultaneously, they would necessarily move in synchronism.

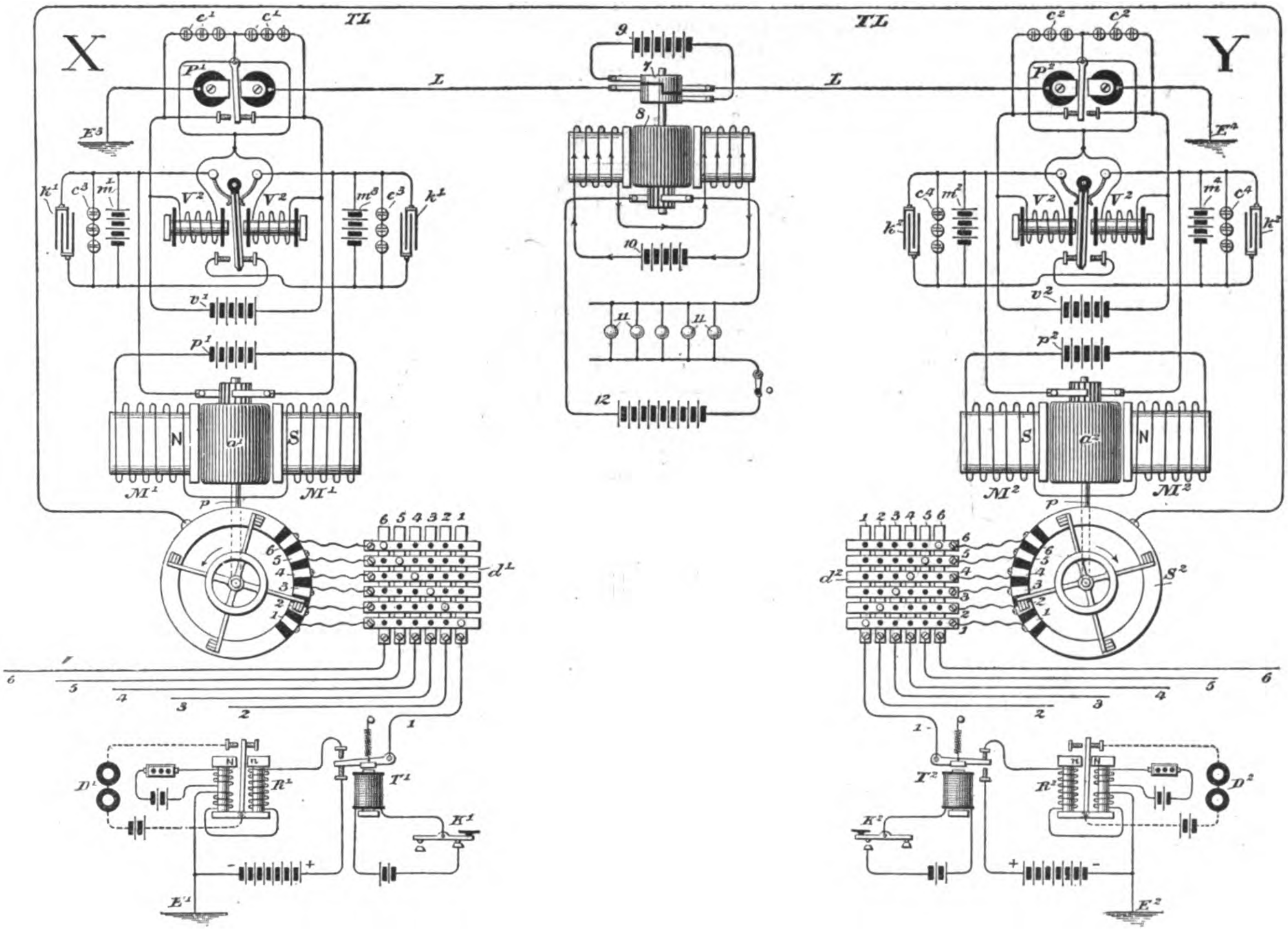


Fig. 1.—Patten's New System of Multiplex Telegraphy.

The apparatus used in the Patten system is simply an elaboration and practical application of this idea. Two electric motors at distant points are made to revolve in synchronism by causing the currents in the armature circuits to be simultaneously reversed through the agency of a controlling line current. The system will be readily understood from the illustration, Fig. 1, which is a diagram of all the operative circuits, including two terminal stations. The system is operated both as a single and a two line system. In the two line system a single synchronizing line is used for controlling a movement of electric motors, and may be used to synchronize the motors for any number of lines. In the single line system the synchronizing current is used both for synchronizing and telegraphing, without either function interfering with the operation of the other. For the sake of simplicity the two line system is selected for description.

In Fig. 1, X and Y represent two terminal stations of a telegraph line. The synchronizing line L L extends from the earth E^3 at X to E^4 at Y, reversing the polarized relays P^1 and P^2 at these stations. At any intermediate point in the line, whether at Y or X, or midway between, is placed a revolving pole changer, the function of which is to constantly reverse a current on this line derived from the synchronizing battery 9. This pole changer is driven by an electric motor having independent field and armature circuits, by which means its speed may be regulated and controlled; it is shown in the middle of the diagram. The lamps 11 are in the armature circuit in multiple arc, and by turning them on or off, the speed of the pole changer may be varied, the field remaining of uniform intensity excited by the battery 10. This pole changer sends rapidly reversed currents continuously to line, and maintains the polarized relays at X and Y in constant and rapid vibration. They necessarily beat in synchronism and are reversed by every half revolution of the controlling motor. These alternations set the pace of as many machines as it may be desired to place in circuit. Very little current is used for this purpose, the battery line on a 100 mile circuit having only about 30 volts potential. The current is necessarily very weak and the vibration of the polarized relays is delicate but constant.

The armatures of these polarized relays could not carry sufficient current through their contact points to drive motors of any size or power, because of their lack of power to prevent sticking and welding at the contact points that would be occasioned by the making and breaking of such currents.

To overcome this difficulty they are caused to drive a powerful vibrator in the same way that a relay actuates a sounder, the vibrator being placed upon a local circuit of low tension V^1 V^2 and this is given sufficient strength and a suitable form to both rapidly reverse and convey the heavy currents of the motor armatures. These vibrators are shown at V^2 in the diagram which is sufficiently clear to explain their operative parts. The polarized relay as it vibrates to and fro places alternately one side and the other of the vibrator in circuit, and its armature is rapidly and strongly pulled first against one contact point and then the other.

The slight spark at the relay points is completely overcome by the liquid condensers C^2 placed as a shunt around these points. With a small current this device is in every way sufficient to prevent any welding or sticking of the points. Not so, however, with the vibrator points. The armature current of the motors, being about 8 amperes at 16 volts, the pressure is sufficient to cause a heavy spark and flame at the breaking of such a current and to weld the armature to the vibrator points, and much time and labor was required to effectively overcome this difficulty. It may be said, however, that this current is now broken continuously at the rate of 800 times a minute without producing a visible spark, and welding never occurs. This, which has been one of the greatest difficulties of the system, was effectually overcome by the system of devices shown. These consist in a special arrangement of liquid and plate condensers placed in parallel as a shunt around the armature points. Neither of these will suffice alone, and only a proper and particular combination of the two will effectually kill the spark. This combination has been found as the result of experiment, and it will suffice to say that the liquid condensers are very large. It will also be observed from the system of circuits that there is always a closed circuit for the batteries M^2 and M^4, which are alternately placed in the armature circuit in opposite directions.

It being now understood how the regulator at some intermediate station keeps the polarized relays in unison movement, and they in turn maintain the local vibrators in corresponding unison movement, it will be explained how this system of devices maintains the motors at distant stations in synchronous rotation. The motors are shown at X and Y by diagram circuits M^1 and M^2; the fields N S are constantly and separately excited by the batteries P^1 and P^2 while the armatures receive their current alternately in opposite direction from the batteries M^1 M^3 at X and M^2 M^4 at Y as the vibrator armatures move to and fro.

The motor armatures are of peculiar construction, differing from a Gramme or drum armature in the manner in which the windings are connected to the commutator. With a continuous current they will not revolve in a constant field, but will vibrate back and forth ; but by reason of their peculiar connections to the commutator segments they will continue in rotation when supplied with a current of rapidly reversed direction, the connections being such that a constant polarity of the armature is maintained with reversed currents, provided the armature turns through a certain arc of the circumference at each reversal of the current. As the system is now used, they are so connected that they move one-fourth of the revolution at each reversal of current. The armature is therefore really moved a quarter of a revolution at each reversal of the vibrator armature. The synchronism is thus corrected automatically four times in each revolution ; it may be made eight or twelve, or more, if desired, but four answers all the requirements of practice, the synchronism being continuous and accurate to a 196th part of the circumference. The spindles of the armature have secured to them revolving trailer arms carrying brushes which sweep over the segmental distributors S^1 and S^2. They are shown flat in the diagram, for clearness, but are evidently at right angles to the spindles, which in practice are vertical, as shown in Fig. 2, which represents the machine in perspective.

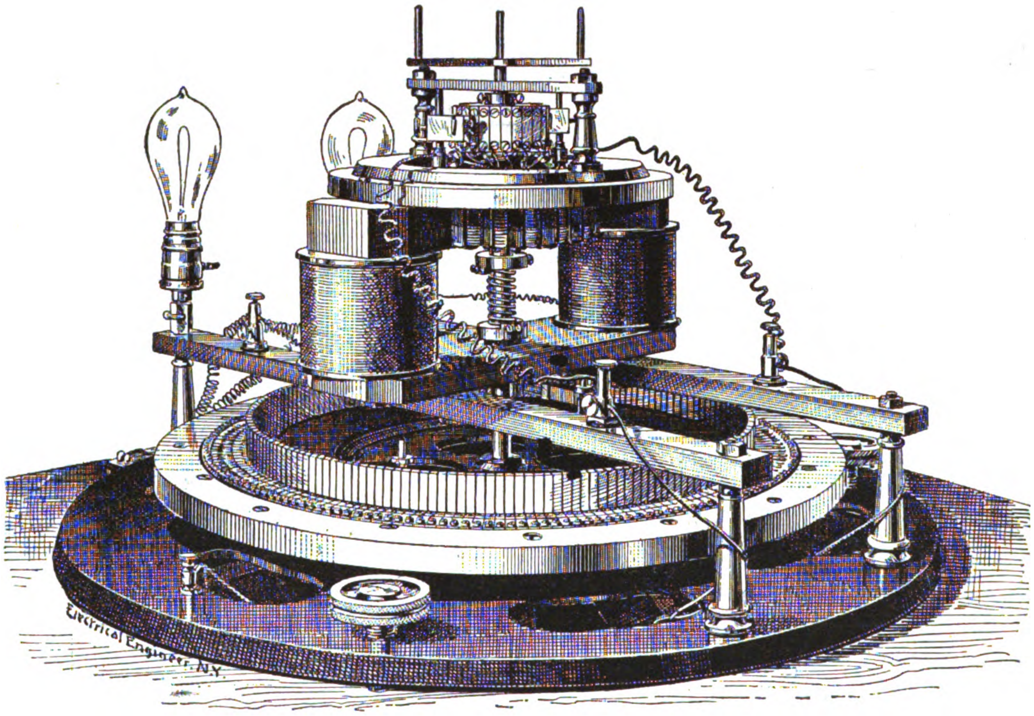

Electrical Engineer, N.Y.

FIG. 2.—PATTEN'S NEW SYSTEM OF MULTIPLEX TELEGRAPHY.

The telegraph line extends also from earth E^1 at X to E^2 at Y, one set of instruments being shown in detail at each end. The circuit may be traced as follows, the operator at X being supposed to be sending, and the operator at Y receiving: From earth, E^1, through the line battery positive to line, transmitter contact T^1, switch d^1, segment No. 1 of the distributer, and through the trailing brush to the large segment of the distributer, to which the line is connected at X; thence over the telegraph line T L to the same distributer parts at Y, out through the switch d^2, transmitter back contact, receiving relay R^2, and completing the circuit at E^2.

Among the many novel features in the systems is first the fact that the distributer is not necessarily cut up throughout its circumference, as in former attempts at multiplex telegraphy, and there may be only as many segments as there are circuits to be used on the line. Thus a sextuplex is shown, and there are six segments in the distributer. In order, however, to acquire a sufficient number of contacts per second for each operator to maintain a practically continuous circuit, it would be necessary to connect No. 1 to four segments in the entire circumference, so that this instrument as well as all the others would receive four impulses of current at each revolution of the machine. The same result is readily accomplished, however, by using only one segment and placing four trailers on the spindle, so that one is always in contact with the segment, while the other three are connected to line by contact with the uncut portion of the distributer. This greatly reduces the cost of such devices.

The system of receiving instruments is also decidedly novel; a polarized relay is used as a receiving relay, but it is not operated with reversed currents as is usually the case. The polarized relay is indeed so modified that it can hardly be called a polarized relay, properly speaking, as by the modifications introduced it is made responsive to intermittent positive or negative currents. The system shown is worked with intermittent positive currents, and is also worked on the open circuit or English system, the receiving relays being rendered operative by putting battery to line from the opposite end, and breaking being effected by opposing the two equal line batteries at the same time from the opposite ends of the line.

One complete set of receiving and sending apparatus is shown at each end. Of course those connected to the main circuits 2, 3, 4, 5 and 6 are identical with those shown connected to the circuit 1. They consist of a key, a transmitter, and the receiving relay normally of the polarized form, but modified as shown in the drawing by the introduction of an extra energizing circuit around one core of the relay, this slight modification rendering the relay operative under the action of intermittent currents of one polarity or sign only. The sounder, D[1], by which the message is read, is operated in the usual way when the receiving relay is actuated by an incoming line current. A sextuplex is shown in the diagram, although excellent results have been obtained on a hundred mile circuit when connected as a "twelveplex." By reason of the fact that all the circuits are shown in the diagram complete as they exist in practice, the system has the appearance of complexity, but it will be readily seen that it is not really so when it is considered that all these circuits are simply magnets, and that there is but a single moving part in each machine, the motion of the vibrators being so slight as to be scarcely noticeable.

In the motor machine, Fig. 2, the segmental distributer is near the base of the machine, which latter is supported by leveling screws by means of which the axis of the armature and revolving fly-wheel can be brought to a true vertical position. The distributer is about 15 inches inside diameter, and has vertical cylindrical walls against which the trailing brushes sweep as they are carried around by the heavy fly-wheel which can be seen inside the distributer. An interior contact is thus obtained, and the tendency is always to increase and preserve uniform contact of the brushes. The lamps are used as resistances in the field circuit of the machine.

A noticeable feature is the construction of the spindle, which is in two parts, the upper and lower halves being connected with each other by a spiral steel spring, as shown. The purpose of this is to prevent any sudden jerk or change of speed of the motion of the fly-wheel, although such a change of speed might happen to the armature; it also facilitates overcoming the inertia of the heavy fly-wheel at starting, this wheel weighing about 20 pounds. The base is open at the bottom so that the fly-wheel can be removed downwards through a hole in the table. The brush carriers of the armature rest in a similar circular frame at the top, which can be removed by lifting it out of place. The entire machine may thus be dismantled without removing any screws or using any tool. When the fly-wheel has been taken out the distributer is lifted off its carriage and slid out sidewise.

The speed is so regulated in practice as to give each instrument, when its circuit is closed, 30 contacts with the line per second, which, admitting four contacts per revolution, would mean an average speed of 7½ revolutions per second, or 450 per minute. But as the distributer motors move at half the speed of the controlling motor in the middle of the line, this one, which carries the pole changer, is driven at about 900 revolutions per minute, producing therefore 1,800 reversals of current per minute on the synchronizing line, and a corresponding number of vibrations of the polarized relay armatures. But as four of these are required to produce a single revolution in the armatures in the distributer motors, their speed is brought to about 450, as stated.

One peculiarity will be observed, namely, that this is not a terminal system as is necessarily the case where isochronous machines are depended upon for preserving synchronism. It is evident that in the system here described any number of polarized relays might be connected in the synchronizing line, and they would maintain as many distributer motors in synchronism. The movement of the machines and synchronism is very hardy as would naturally be expected, the motors exerting about one-eighth of a horse-power. The machines may be disturbed and lifted off their base and allowed to drop, without disturbing the synchronous movement. The trailer arms may in fact be struck and the synchronism disturbed, but unless the machine is completely stopped, it will soon come into synchronism again, as there is a tendency to automatically correct the motion, which is measured by the power of the machine itself, having little or no load to carry other than that due to friction and the grinding of the brushes against the walls of the distributer. By using machines of such power, however, these contacts are made very secure and reliable. Under ordinary conditions of line and weather the system will work at "twelveplex" on a good one hundred mile circuit with reliability and decision, the circuits being practically so many independent lines.

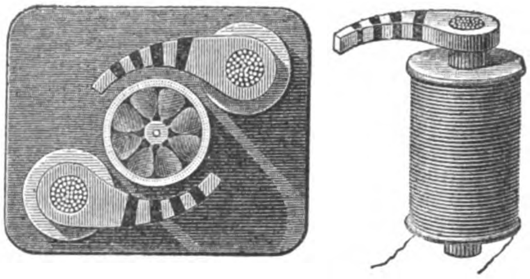
HUYGHEN'S GEARING IN ILLUSTRATION OF ELECTRIC INDUCTION.

At a meeting of the Physical Society, held May 16, Lord Rayleigh exhibited and described an arrangement of "Huyghen's Gearing in Illustration of Electric Induction." This gearing consists of two loose pulleys mounted on the same axle, with an endless cord laid over them, the loops or bights of which carry weighted pulleys, whose planes are parallel to the axis on which the upper pulleys turn. If one of the latter pulleys be started to rotate, the other one turns in the opposite direction until such time as the speed of rotation of the first becomes constant. Whilst this constant speed is maintained, the second pulley remains stationary, one weight being raised and the other lowered, but on retarding the motion of the first pulley, the second commences to turn in the same direction as the first. It will be noticed that the phenomena are analogous to those which occur in electric induction, where starting or increasing a current in one circuit induces an opposite current in a neighboring circuit, whilst decreasing or stopping a current induces one in its own direction. Lord Rayleigh pointed out that in this apparatus there is nothing strictly analogous to electric resistance, for the friction does not follow the same law. The analogy, he said, was complete as regards there being no change of potential energy, and the mathematical equations for the kinetic energy of the system are precisely the same as those given by Maxwell for electric induction.

THE WRIGHT-FERRANTI ALTERNATE CURRENT METER.

At the close of a lecture delivered by Dr. Fleming before the London Society of Arts on the alternate current phenomena recently described by Prof. Elihu Thomson before the American Institute of Electrical Engineers,[1] the lecturer showed a new alternate current meter designed by Messrs. Arthur Wright and S. Z. de Ferranti. As shown in the accompanying engraving, it consists in its latest form of a pair of vertical electro-magnets, the magnets having divided iron cores. To the poles of these magnets are attached curved horns of divided iron which lie in a horizontal plane. These curved horns are magnetically throttled at intervals along their length with copper bands. The curved horns embrace a circular space in which can revolve a light copper or iron shallow cylinder of thin metal. This cylindrical band forms the periphery of a light wheel capable of rotation on a vertical axis. Geared to this axis is a counting mechanism. The axis also carries a vane having mica blades.

The electro-magnetic principle said Dr. Fleming, may be briefly described thus: The throttling of the curved iron horns causes the rapidly reversed magnetism to take the form of a lateral diffusion of lines of force from the sides of the horns. In effect a series of oppositely-named magnetic poles travels along the horn from the base, where it is in contact with the top of the electro-magnet to the tip. These poles are represented by a series of bunches of lines of force, setting out laterally from the sides of the horn, and traveling up it. The lateral passage of these lines of force through the metal band which forms the rim of the movable wheel generates in it eddy currents. These are continually repelled by the moving field producing them, and hence a motion of rotation is given to the wheel by the alternating magnetism of the magnetic poles.



Figs. 1 and 2.—The Wright-Ferranti Meter.

The speed of rotation, being retarded suitably by the vanes, can be made to be proportional to the current strength of the current exciting the magnets, and hence the total turns of the wheel in a given time to the total electric quantity flowing through the meter.

OPTICAL TELEGRAPHY.

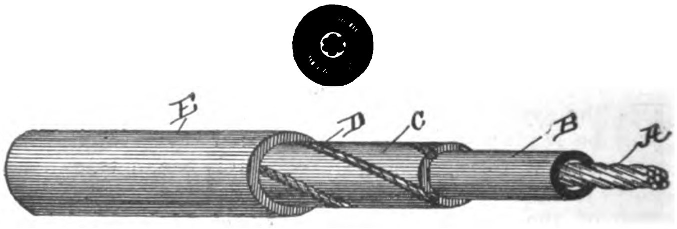
The flashing of a message from Mt. Reno to Mt. Graham, 125 miles, by aid of the heliograph, marks the greatest achievement in this method of optical telegraphy yet made. It is, perhaps, not generally known that the Signal Service Department has been making extensive experiments in this direction for several years, and it may now lay claim to having the longest and most complete heliographing line in the world. Its operations extend from Fort Stanton, in New Mexico, to Whipple Barracks, in Arizona, more than 1,000 miles, with ramifications leading in different directions. The terminal stations, twenty-five or more, connect with the general telegraph systems of the country, bringing the almost impenetrable reserves of New Mexico and Arizona into direct communication with civilization or the governments. The system is of immense advantage in Indian warfare, where ordinary telegraph lines have not penetrated, and where they could not be maintained in case of hostilities, were they set up. General Greeley recently sent a despatch to Washington from Bowie Peak, Arizona, the message being flashed from peak to peak, over gaps of forty-five miles, touching at Mt. Graham, Table Butte, Saddle Peak, Pinal Mountains, Lookout Peak, Baker's Butte, Squaw Peak, Bald Mountain to Whipple Barracks, from where it was transmitted by the ordinary system. The possibilities of the heliograph are not limited, however, to the 125-mile record, and understanding its value from a military point of view, the Signal Service Department will not fail to develop it as far as possible. The heliograph is a simple little instrument and easy of manipulation. A small mirror is set on a tripod in such a manner that the rays of the sun reflected from its surface may be thrown in any direction and kept at the point desired by mechanism compensating for the rotation of the earth on its axis. These rays, interrupted so as to show flashes of long or short duration, representing the ordinary Morse alphabet, are watched and their variations noted at the distant station.

THE NEW COBB CABLE.

We illustrate in the accompanying engravings a new type of cable recently brought out by the Cobb Vulcanite Wire Co., of Wilmington, Del., and designed especially for underground work. As will be seen, the metallic conductor A is inclosed in rubber tubing B made sufficiently hard to resist impression by the weight of the conductor.

About the hard rubber tubing there are wound spirally cotton cords which are embedded in a soft insulating material C, such as paraffin; this upon hardening becomes sufficiently tenacious by exposure to resist attenuation or impression by the weight of the material inclosed within it. The whole is finally covered by a tube of hard rubber to resist abrasion in the manipulation of the wire, such as the drawing in and out of conduits.

In the manufacture of the cable Mr. Cobb proceeds as follows: The conductor A, inclosed in its insulating material B, is first wound with the cord D, which is preparatorily soaked in an insulating compound, such as paraffin. The outside insulation E is then applied in the form of the rubber tubing referred to, through which the combined elements A, B, and D are drawn, the spirally-wound cord D serving to centre them inside the tubing, and thus permit of the application of the soft insulation C in an equal thickness throughout its entire extent, and which is applied by forcing paraffin, reduced to a liquid condition, through the length to be treated between the insulating parts B and E, the paraffin thus embedding the cord.



The New Cobb Cable.

Among the particular advantages claimed for the wire are that it affords extraordinarily high insulation; that as the insulating medium is formed in separate layers or thicknesses the joints in the several thicknesses of the parts B and E may, in producing desired lengths of the wire, be formed out of coincidence with each other, thereby reducing the possibility of leakage at the joints; that the requisite flexibility of the wire is not prevented by the comparatively great thickness of insulation employed, which, if entirely of hard rubber, would be undesirably stiff, and that any flaws that may exist in the parts B, C, and E are not liable to coincide, thereby affording a practically flawless insulating-covering for the conductor A.

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[1] See The Electrical Engineer, April 9, 1890, for full report.

ON THE PERMEABILITY OF IRON AT RIGHT ANGLES TO THE DIRECTION OF MAGNETISATION.—II.

BY A. E. KENNELLY.

The theoretical relations existing between the inductances may now be considered.

Let a magnetizing force $\mathbf{H}$ act upon a portion of homogeneous iron in the direction of X, a rectangular co-ordinate axis, and induce a magnetization of amount $\mathbf{I}$ in the same direction according to the relation, $\mathbf{I} = f(\mathbf{H})$. Then the induction per unit area $\mathfrak{B} = \mathbf{H} + 4\pi f(\mathbf{H})$, and a closed solenoid surrounding a ring of this iron will, when measured with feeble currents, show an inductance $\mathbf{L}_x$, expressed by the relation $\mathbf{L}_x = l\dfrac{d\mathfrak{B}}{d\mathbf{H}}$, l being the coil's inductance in a medium of unit permeability. Hence the locus of $\mathbf{L}_x$ referred to $\mathbf{H}$, should be a curve whose ordinates are proportional to $\dfrac{d\mathfrak{B}}{d\mathbf{H}}$ at every point.

If now $\mathbf{H}$ receive a small increment $d\mathbf{H}$ at right angles, or parallel to the Y axis, then, provided that the iron is isotropic, the resultant magnetic force will lie in the plane $X\,Y$, and make an angle $\tan^{-1}\dfrac{d\mathbf{H}}{\mathbf{H}}$ with X. The component magnetization will be $\mathbf{I}_y = \dfrac{d\mathbf{H}}{\mathbf{H}} f(\mathbf{H})$; the corresponding induction, $\mathfrak{B}_y = d\mathbf{H} + 4\pi\dfrac{d\mathbf{H}}{\mathbf{H}} f(\mathbf{H})$; and the apparent inductance of the original solenoid $\mathbf{L}_y = l\dfrac{d\mathfrak{B}_y}{d\mathbf{H}} = l\left[1 + 4\pi\dfrac{f(\mathbf{H})}{\mathbf{H}}\right] = l\,\mu$; where μ is the permeability of the iron in the direction X. The locus of $\mathbf{L}_y$, referred as before to $\mathbf{H}$, will therefore have its ordinates everywhere proportional to μ.

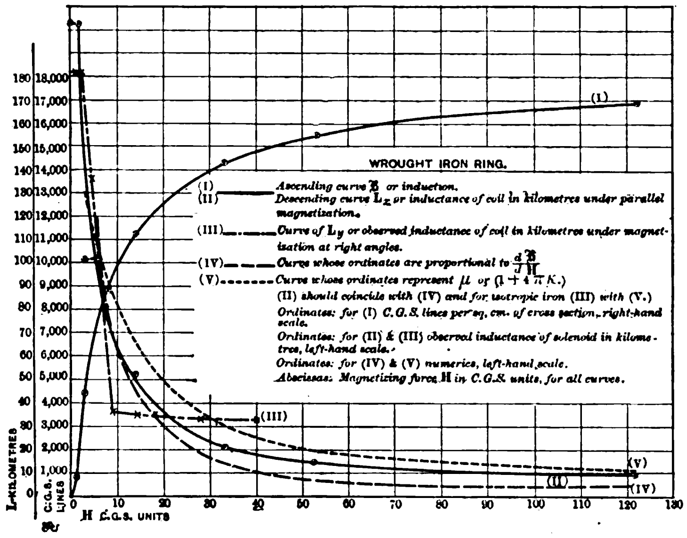


FIG. 3.

If, however, the iron is æolotropic, the magnetization along Y will be some function $\varphi(\mathbf{H}, d\mathbf{H})$ of both $\mathbf{H}$ and $d\mathbf{H}$, so that any evident divergence between these two curves of $\mathbf{L}_y$ and μ, shown by experiment, marks the departure of the iron in corresponding degree from the initial isotropic state.

The results given in Tables III.-VI. are plotted in Figs. 3, 4 and 5.

Examination of these curves shows:

1. That the curves of $\mathbf{L}_x$ do not indicate the very sudden rise in the value of $\dfrac{d\mathfrak{B}}{d\mathbf{H}}$ known independently to take place within the first 10 units of $\mathbf{H}$. This may perhaps be accounted for by supposing that at this stage the iron molecules are in a critical magnetic condition, and that the feeble magnetic force in the inductance test is insufficient to precipitate them.

2. That after $\mathbf{H}$ exceeds some 30 units, $\mathbf{L}_x$ appears in each case to be greater than $\dfrac{d\mathfrak{B}}{d\mathbf{H}}$. This can only be attributed to error in the observation or method.

3. That in Figs. 4 and 5 the curves of $\mathbf{L}_y$ for values of $\mathbf{H}$ not less than 50 are rather more divergent from those of μ than $\mathbf{L}_x$ from $\dfrac{d\mathfrak{B}}{d\mathbf{H}}$.

4. That in (Fig. 3) the case of wrought iron there is a marked discrepancy between the two curves $\mathbf{L}_y$ and μ, the former being considerably in excess for magnetizing forces above 20, and repetition of the experiment has checked this result. The point of abrupt change of curvature in $\mathbf{L}_y$ appears to take place at a magnetizing force of 9, and this, by a curious coincidence, is the value given by Mr. Shelford Bidwell for the "Villari critical point" in a particular instance.

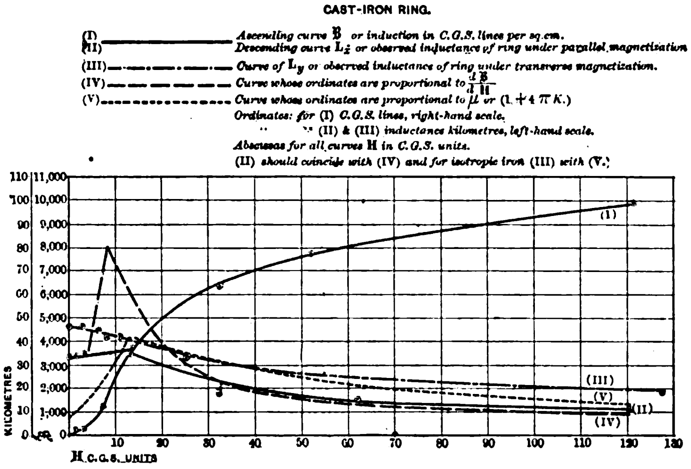


FIG. 4.

While, therefore, the results with the rings of cast iron and tool steel are doubtful, it may be safely inferred that the sample of wrought iron distinctly indicated æolotropic behavior for magnetizing forces exceeding 30 units, and this is not unreasonable when we remember that according to Dr. Hopkinson, iron attains its maximum length at a magnetic force of 20. The contraction which sets in after that point may do such work against intermolecular forces as will by reaction affect the ratio $\dfrac{f(\mathbf{H})}{\mathbf{H}}$, or K.

If this be admitted, Weber's theory cannot be regarded as theoretically correct for values of $\mathbf{H}$ exceeding 30, and beyond that point at least, any strict theory of magnetization must involve a consideration of molecular stresses and displacements.

Weber's theory, however great a stride over pre-existing conceptions, and however completely it enabled existing knowledge to cope mathematically with the intricate phenomena of magnetization, is based upon what appears to be a very arbitrary hypothesis. It assumes that the restituting force on the molecule varies directly with the sine of the displacement angle. The mechanism by which any such forces—magnetic or mechanical—could be exerted, unless as the result of some underlying hypothesis, is difficult to imagine. The amendments that Clerk-Maxwell introduced to enable it to cover the phenomena of hysteresis and permanent magnetization, ingenious as they are, must also be confessed as very arbitrary. While his limitations of strain and "set" in the rotation of the molecules are perhaps the only ones capable of yielding a mathematical solution moderately simple, yet rationally complete, it tasks the imagination to suggest why just those particular limitations should naturally suggest themselves.

Moreover, the appearance in certain conditions of a stage of magnetic instability at which the ratio of magnetization to magnetizing force suddenly becomes discontinuously great, such a condition as has been observed by several physicists, and lately pointed out by Profs. Ewing and Thompson, cannot be accounted for by the Weber-Maxwell theory in its existing form, which only admits of continuous changes.

It is usually much easier to discover imperfections in existing theories than to replace them by others less objectionable, but the following theory is offered as a suggestion. It is in reality only an adaptation of that promulgated by Prof. D. E. Hughes in his papers to the Royal Society ten years since. In the following form, while embracing all those phenomena that Weber's theory explains, it has the advantage of explaining the stage of molecular instability, without being cumbered by special inherent limitations in the direction and magnitude of the restituting forces. At the same time it has the disadvantage of so attempting to portray the operations concerned in magnetization, that a complete mathematical solution of the phases in transition is at present apparently beyond reach. It is also subject for its existence to the admission of an unusual postulate on interpolar distances to be later specified. We may call it the "chain" theory of magnetization.

Suppose the iron to be homogeneous, and to have n molecules per unit volume. As in Weber's theory, let the magnetic moment of each molecule be m, which varies only with the temperature. The maximum magnetization possible is then $I = nm$.

In virgin iron under no magnetic influence these molecules will be so arranged that there will be no resultant magnetization. This we may suppose to result, not from any indiscriminate scattering of the magnetic axes in space, but from the formation under mutual attractive influences, of closed loops or chains in the molecules. These chains may interlace in every conceivable manner, some may bifurcate or trifurcate in parts; but the characteristic feature of the magnetic arrangement in soft virgin iron will be the existence of magnetic chains made of two or more, and usually many, molecules as the rule, and the existence of unchained molecules, isolated exceptions whose unstable condition renders them likely to fall into and form an offshoot loop of the nearest chain upon the slightest impulse. Let it also be granted that the seat of magnetic force is at the two extremities or poles of a magnetic axis connecting them fixed in the molecules and of length l, while the average distance, d, intervening between the opposed poles of adjacent molecules in a chain is small compared with l. It may be remarked that this assumption is not equivalent to making the average intermolecular distance small compared with the dimensions of the molecule, for in the absence of knowledge concerning the nature of molecules, we are at liberty to place their poles in their "ether envelopes," or external, it may be, to their own proper space, provided that their poles are in rigid connection with them. The tendency of the magnetic chains is to contract and reduce the average distance d, a tendency resisted by those forces which regulate the proportions and play of the molecular structure. This granted, it is easily seen that the magnetic moment of any one chain about any diameter as an axis will be small in relation to the moment of the molecule, while the chains being in all curvatures and azimuths, their aggregate moment in the mass must be vanishingly small.

Considering a single molecule in any chain, if r be the distance from one of its poles to any other pole in the mass, the magnetic force exerted between them will be a vector force ρ expressed by the relation $\rho = m^2 \, \mathrm{f}(r)$, where $\mathrm{f}(r)$ may, or may not, be the function of inverse squares holding for sensible distances. Then the forces which are active in determining the direction of our selected molecule, assuming it to be free to turn on its center in any direction, but to have the position of its center prescribed by structural forces, will be two resultant magnetic forces, viz., $\Sigma\rho_p$ on the positive, and $\Sigma\rho_n$ on the negative pole, the summation being made vectorially and extended to every pole in the whole system. Since, however, d is small compared with l, the effective sphere of attractive force is practically confined to the nearest one or two molecules along the chain, while the influence of neighboring molecules in other chains is a disturbing force generally small.

These two forces, $\Sigma\rho_p$, on p the positive pole, and $\Sigma\rho_n$ on n the negative pole, will be equivalent to a uniform magnetic field, vectorially h say, acting on our molecule in the direction of its axis, and a single force—vectorially φ, acting upon the molecular center tending to give it a motion of translation, which tendency is presumed to be held in equilibrium by the mechanical forces of the molecular framework. This equivalent field h, and single central resultant φ will exist for every molecule; and with reference to the chains, each h will be approximately tangent to the radius of curvature at that point, while φ will generally be directed towards the interior of the chain.

If now a vector magnetizing force, H, be brought to bear upon the system, every molecule whose axis is not parallel to H, will be magnetically deflected. Considering any single molecule, if its h remained constant, then its new axial position vectorially $\mathfrak{A}$, say, in space, would be in the resultant of h and H, or in line with the vector $H + h$; but since nearly every molecule which previously contributed towards its h has also slightly deflected, the real new axial position will be in the vector line $\mathfrak{A} = H + (h - \Delta h)$, Δh representing the secondary disturbing effect on h.

The angle of deflection included between h and $\mathfrak{A}$ will vary for each molecule, from zero for those originally in line with H, to a maximum, for those whose axes were originally nearest to a right angle with H. It is to be noticed that no matter what angle each chain may individually make with H, in parts or in planes, there will be always two, and often more than two, molecules opposite in each chain, originally set so nearly perpendicular to H that their deflections in that chain are a maximum.

Let us call these favored molecules of a chain the "leaders." Then if the chains were all composed of the same large number of molecules and similar in every respect, so arranged that however intimately they might be interlaced, no two chains ever approached within the sphere of mutual disturbing influence, the deflection of all the leaders would be equal, independent of the angle between their respective chain planes and H; for with all leaders h and H would be at right angles; h would have a common value; so also would Δh, and thus the deflection of each would be $\tan^{-1}\left(\dfrac{H}{h - \Delta h}\right)$.

It may readily be granted that what would then be rigidly true for an ideally homogeneous system, is nearly true by the theory of probabilities in a system partly subject to homogeneity, and partly left to fortuitous combinations; so that the maximum deviation would be nearly alike in all chains and equal to the average value of

$$\tan^{-1}\left(\frac{H}{h - \Delta h}\right).$$

As H is now gradually increased, all the deflections increase, but the increase is most rapid in the leaders to which we may therefore confine our attention. If h were constant, the restituting moment due to h would increase with the angle of deflection; but owing to the secondary disturbance Δh, this moment does not increase in proportion to the moment of deflection due to H. This continues until h has been so much reduced by Δh, that a critical point is reached, and first reached in the leaders, when an increment in H, and therefore in the deflection, makes the restituting moment—just previously a maximum—diminish. At this stage nearly simultaneous with all the chains, the leaders break from their neighbors and rotate into parallelism with H. These neighbors, whose deflections had been next greatest in value, suddenly deprived of support, suffer a large increase in Δh, are precipitated into dislocation, and the example thus set is followed under transmitted influence all along the line, till it terminates at the motionless molecules or nodal points originally parallel to H. The desertion of the leaders is thus the signal for the immediate disruption of the chains, which vanish without leaving a trace of their existence, and it may be that on the subsequent complete withdrawal of H, the associations, arrangement, and chains formed by the molecules under their once more ascendant mutual attractions may totally differ from those gone by.

If, now, elastic resistance to rotation be introduced as a factor, together with the stresses affecting the isotropic condition of the medium, the materials are present for suggesting every known description of paramagnetization.

A few of the leading consequences of the theory may be outlined, as follows :—

With a homogeneity of chain formation in marked degree, and very small resistance to rotation, the critical stage should be very pronounced, especially if the stresses produced by the magnetization are either absent or removed by opposite imposed stresses. Such magnetization would be almost entirely temporary, and there would be no coercive force. On first applying magnetic force, there would be a period of steadily increasing feeble magnetization, then a sudden bound of almost complete magnetization, followed by no subsequent change with any increase in magnetic force.

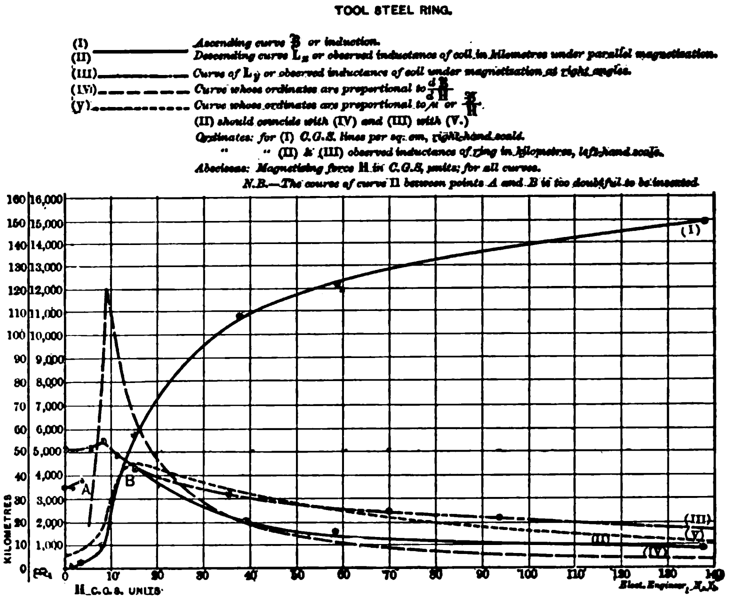


FIG. 5

If in the next instance elastic resistance to rotation were introduced, the first stage of feeble magnetization would not sensibly differ, and the critical stage would be reached at the same force, but the magnitude and duration of the bound would be modified in proportion to the resistance. The molecules would be retarded and the chains might not instantly or coincidently break up on the departure of their leaders. Even after the disappearance of the chains, infinite magnetic force would be needed to produce in every molecule an indefinitely close convergence to parallelism, and the parallelism once produced would be more or less subpermanent.

Finally as reaction stresses and want of chain homogeneity are introduced, the critical stage in the magnetization, although never entirely effaced, is more and more concealed, and the curve of $\frac{d\mathfrak{B}}{d\mathrm{H}}$ shows a lower and less tapering apex. Between these limits, all the characteristics of magnetized iron seem to be included.

As regards the stresses produced in iron, by the process of magnetization, we should expect to discover a voluminal expansion up to the critical stage owing to the reduction of the φ forces, which in the virgin state are directed towards the chain centers, as already noticed. Once the critical stage is reached, however, there should be a linear shrinkage in the direction of H accompanied probably by an expansion in all directions at right angles, owing to the mutual attraction of all the consecutive polarized molecules. This shrinkage should be instantaneous and final in ideally soft and homogeneous iron, while it would be gradually effected to an equal limiting amount in iron subject to elastic resistance.

This deduction appears to agree fairly with the observed facts so far as they are recorded for iron, but the anomalous behavior of cobalt and nickel in this respect has yet to be accounted for, and in fact as Dr. Hopkinson pointed out in his able address to the London Institute of Electrical Engineers, this year, no theory of magnetization can ever be considered complete until the origin and phenomena of molecular polarity, the essences of the whole subject, are satisfactorily explained.

THE LAURENT-CELY ACCUMULATOR.

THE special features of the Laurent-Cely accumulator, which is constructed by the Société Anonyme pour le Travail Électrique des Métaux, consists in the special nature of the lead paste employed, and in the manner in which it is applied to the plates. The active element is a mixture of chloride of lead and chloride of zinc. The fused chloride of lead has a density of 5.6 ; by incorporating chloride of zinc with it in certain proportions the density is reduced to 4.5. This mixture, brought to a state of fusion, is run into cast-iron molds in the form of small buttons with rounded edges. After cooling, the buttons are washed to remove the chloride of zinc, and thus to render them somewhat porous. Their density then varies from 4.2 to 3.4. The buttons which serve for the manufacture of the negative plates are then arranged in a metallic mold, into which antimonial lead is run ; this surrounds the buttons with a frame which holds them fixed in their positions. The negative plates are mounted in cells filled with acidulated water and provided with zinc electrodes. The composite and zinc plates are then short-circuited. The hydrogen which is disengaged upon the positive electrode reduces the chloride of lead, and there are thus obtained buttons of spongy lead of a density between 2.5 and 3.1, while that of ordinary lead is 11.35. The buttons used in the manufacture of the positive plates are first transformed into spongy lead, then heated in the air to oxidize them, and transformed into spongy litharge. They are fixed, like the negative buttons, in a frame of antimonial lead. The Laurent-Cely accumulator is employed for the lighting of the *wagons lits* on the Chemin de Fer du Nord, and has also served to drive a motor working an electric capstan.

A NEW FORM OF CHRONOGRAPH.

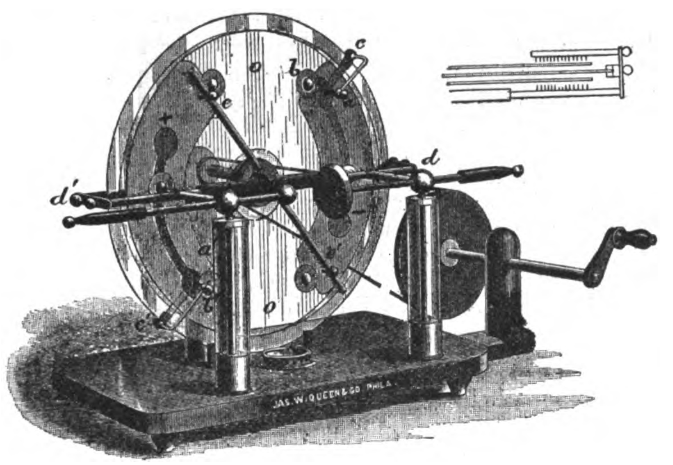
A new form of electric chronograph, due to the Rev. F. J. Smith, is described in the May number of the *Philosophical Magazine*. The instrument is original in many respects, although the time traces are made by means of electro-magnetic styluses, as is the case in many other forms of time-measuring apparatus. The principle involved in the construction is that of Attwood's machine A carriage, to which a sheet of smoked glass is attached, is impelled horizontally by means of a cord attached to a weight. The weight, after acting through a certain length of fall, is arrested by means of a table of adjustable height, and the carriage moves on with an acquired velocity which is found experimentally to be constant during the whole length of a trace.

SOMETHING MORE ABOUT THE ACTION OF THE TOEPLER-HOLTZ MACHINE.

BY ELMER G. WILLYOUNG.

In the issue of The Electrical Engineer for May 14th, there appears an article by Prof. Marshall Henshaw on the Toepler-Holtz machine and its theory of action; in this article Prof. Henshaw rejects an explanation published in *Science*, 1884, and recently republished in a special circular issued by Messrs. Queen & Co., as "hardly satisfactory" and publishes another which he proposes as a substitute. Prof. Henshaw fails to state, however, why he considers the first mentioned theory as unsatisfactory and what special advantages the proposed explanation possesses over it. A careful comparison of the two explanations will show that Prof. Henshaw's differs from that published by Messrs. Queen& Co. only in assuming that the sector D (granting it its initial charge) draws electricity of the opposite kind from the *discharging rod*, whereas the latter explanation assumes the sector as causing the same action at the diagonal comb e^1. The remainder of Prof. Henshaw's explanation is exactly the same as the other except that the various portions of the machine spoken of lie 45° behind the corresponding portions spoken of in the explanation published in *Science*, since the starting point itself is 45° behind.

The older explanation referred to is practically an adaptation of that offered by Silvanus P. Thompson, explaining the action of the old style Holtz machine. I do not know whether it was ever actually verified by Mr. Thompson or not; I feel quite sure, however, that Prof. Henshaw could not have verified his by experiment as the following will show:


c
b
e
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JAS. W. QUEEN & CO. PHILA.

Action of The Toepler-Holtz Machine.

A machine was set up in the laboratory of Messrs. Queen & Co., and a many pointed metallic brush mounted upon an insulating stand so that it could be presented to the front of any portion of the revolving plate; this brush was connected by a long chain to a delicate electroscope some distance away. The plate was then revolved until sparks were given off by the discharging rods; it was then stopped and the two dischargers placed in metallic connection so as to eliminate any inductive action of the Leyden jars; the paper sectors and brushes were also thoroughly grounded. According to Prof. Henshaw's explanation the portions from e to b and from e^1 to b^1 of the revolving plate should not be neutral; presenting the points of the brush to these portions they were found to be strongly electrified, the upper one plus if the right hand discharger was plus, and the lower one minus, or vice versa if the left hand discharge was plus. In the same way the portions d to e^1 and d^1 to e which should be strongly electrified, if Prof. Henshaw is right, were found to be absolutely *neutral* though the electroscope was so delicate that it would indicate the electrification caused by lightly rubbing a vulcanite rod four feet distant.

A number of tests of the polarity of the machine were made at the same time as the above; out of thirteen successive tests, the rods in each case being placed in metallic contact for some time so that the jars might be thoroughly discharged before making the next test, six showed the right hand discharging rod to be positive; sometimes the rod would be positive and then negative and sometimes of the same polarity twice in succession. Tests were also made in rapid succession, so that there was considerable residual charge still remaining in the jars when the plate was revolved for the next test. It might now be expected that the polarity of the machine would continue the same; strange to say, however, the alterations were just as frequent as before.

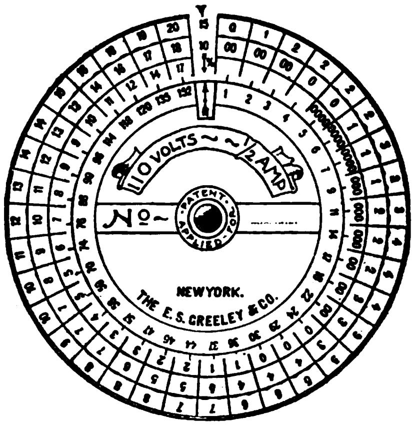

Fig. 1.—Greeley Automatic Wire Calculator.

Undoubtedly there is much to be desired in the way of an explanation of the action of this well known machine; the rapid development of the more practical applications of electricity has distracted attention from this as well as many other phenomena of great scientific interest. As far as I know, no one has yet made anything like such an experimental investigation of the Toepler-Holtz machine as is being made in the case of dynamos and motors dozens of times each week.

AN AUTOMATIC WIRE CALCULATOR.

The large increase in the number of public buildings as well as private dwellings, constantly being wired for electric lighting has necessarily put a large part of the work into the hands of somewhat inexperienced men, who, as a rule, are provided with charts in order to ascertain the proper size of wires to use for the various circuits carrying incandescent lamps, both within buildings and for the outside line work.

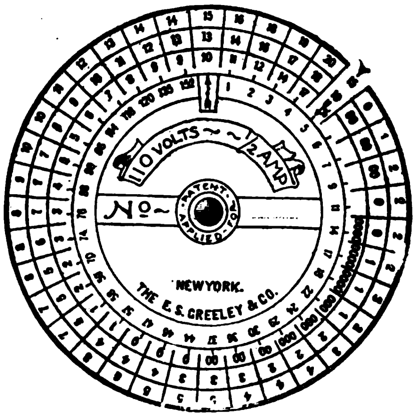

Fig. 2.—Greeley Automatic Wire Calculator.

To still further simplify the work of the wire man and to render his work reliable and accurate, The E. S. Greeley & Co., of this city, have recently brought out an "automatic wire calculator." This consists of two discs of stiff cardboard of unequal size, the smaller one being mounted in the centre of the larger and made to revolve thereon, as shown in the engraving, Fig. 1. On the back of the larger cardboard are full directions for the use of this unique and useful tool. The one shown in the above engravings is arranged for the calculation of wire for a 110-volt distribution, and we understand that there is also another one in preparation arranged for 55 volts.

The process of calculation is shown in the illustrations, Fig. 1 showing the two discs in their normal position and Fig. 2 showing the calculation determining the size of wire suitable for use to carry a current for 5,000 lamp-feet. The number of lamp-feet is obtained by multiplying the foot distance by the number of lamps; that is, 50 lamps at 100 feet, or 10 lamps at 500 feet, or 500 lamps at 10 feet, when multiplied one with the other give 5,000 lamp-feet. It is then only necessary to turn the inside dial until the figure 5 on the scale of the inside disc comes opposite the arrow which is upon the outside disc, which operation is shown in Fig. 2 of our illustrations. When this has been done the arrow upon the inside disc will point to the size of wire which it is desirable to use, and which in the accompanying illustration is shown to be No. 10 for a 5 per cent. drop, No. 13 for a 10 per cent. drop, and No. 14 for a 15 per cent. drop.

With a simple aid of this kind at hand, properly applied, there ought to be no difficulty in the proper proportioning of circuits even by the most inexperienced.

THE UTICA N. Y. BELT LINE ELECTRIC RAILWAY.

The Utica Belt Line Railway, which is herewith illustrated, has recently been put in operation under the Thomson-Houston electric railway system, and is a fine piece of construction which embraces more than a few conditions not found in ordinary electric railway construction work. The total length of the track is 20.37 miles, 15.84 miles single, and 2.27 miles double track. Seven and eight-tenths miles of single track is located near the curb line, on which the single bracket suspension is used, on the remaining track cross suspension is employed with one or two exceptions. There are 32 turnouts aggregating 6200 feet in length, 18 single and one double track curves, and eight steam railroad crossings. The maximum gradient is 3 per cent., and occurs at a distance of about 1500 feet from the power station, and extends a distance of about 300 feet. There is one curve with a 50 foot radius, which has a grade of 5 per cent. The power station is a handsome one story brick building, equipped with all modern conveniences, and necessary minor apparatus for a first-class power plant. It is well built, finely lighted, and the arrangement of the apparatus is admirable. At present three 200 h. p. Armington & Sims compound condensing engines are in place, and a battery of four boilers for supplying the necessary steam. The station is admirably situated as far as coal and water supply is concerned, the the water being obtained from a large canal on one side, while the coal is dumped directly from the steam railroad cars on the other side directly into the boiler room Six 80 h. p. Thomson-Houston railway generators are now in daily use. The station switch-board which contains the auxiliary electrical appliances is very handsome and finely constructed throughout. The car equipment consists of 25 cars, each equipped with two 15 h. p. Thomson-Houston railway motors. The power station, and, in fact, the entire installation, reflects great credit upon the railway company, which, from the start, manifested its determination to use only the best material and forms of construction. The successful operation of the road since its start has shown this to have been a wise plan.

THOMSON-HOUSTON ELECTRIC ROAD, UTICA, N. Y.

The Holyoke Water Power Company are to consider plans for enlarging the capacity of their electric light plant. The new contract for city lighting has been given to the company and additional circuits will necessitate an enlargement. The company's electric light station is now located in their Cabot street mill, but they will probably erect a new building. No plans have been discussed yet.

ELECTRIC TRACTION DATA.[1]

BY A. RECKENZAUN.

Of the various questions connected with electric traction, the branch to which I have the honor of calling your attention to-night, appears to me fundamental to a complete knowledge of the subject. It relates mainly to tractive force and mechanical resistances on tramways. It is a subject which is not as fully appreciated by electrical engineers as it should be, although it forms the very basis of street locomotion, and I venture to say that future improvements in the economy of electric traction will in a large measure depend upon minute attention to details relating to this branch of the science. The very existence of tramways as substitutes for the common road, is concentrated in one point, viz., the reduction of tractive resistance to a minimum.

It is a well-known fact that the traction expenses on horse tramways constitute about two-thirds of the entire working expenses, and it has long been the aim of engineers to find an economical mechanical substitute for animal power. Electricity has found great favor with tramway men in the United States, and there is every probability of similar developments in Europe at a not distant date. Improvements can only be brought about by experience, and experience must be gained in actual practice and by careful observation. These, again, can be supplemented by data obtained from those who preceded us, and it is my intention to bring, in a condensed form, such data, from which you will be able to draw your own conclusions, and which will guide you in future and progressive efforts.

In order to provide facility for traction, we must have a solid, permanent way, and excellent rolling surfaces. The practical value of a good rolling surface can scarcely be over-estimated. The rails must be rigid, parallel, and fixed to solid foundations. In America, flat step rails without grooves are used; these offer less resistance to traction than grooved rails, but, as a rule, they are not so solidly laid as English rails. According to Mr. D. K. Clark, the resistance to traction on an ordinary railway may be as low as 6 lbs. per ton; but so low a resistance cannot be obtained with grooved rails which are exposed to the incidents of mud, grit, stones and dirt, and which, moreover, have frequent and sharp curves.

Mr. Henry Hughes deduced from experiments on tramways a tractive resistance of about 26 lbs. per ton; often more, occasionally less. Such high resistances as these are readily accounted for, when it is considered that the flanges of the wheels frequently take a bearing on the bottom of the grooves, or on the dirt embedded therein, at the same time that the wheels roll on the surface of the rail; for thus the wheel rolls on two different radii simultaneously, and grinding of surfaces in contact must result. It may also occur that one wheel is running on its proper bearing surface, whilst the other, belonging to the same axle, has its flange touching the bottom of the groove, when by virtue of different circumferential velocities, additional friction is introduced. Sometimes the rails are a little out of gauge. All these circumstances augment the tractive force requisite with grooved rails. The horse, if it could speak, would be a good witness, but failing his verbal evidence, the dynamometer has been consulted. Better than the mechanical dynamometer, however, is the ammeter. A dead beat ammeter indicates instantly the slightest variations of tractive resistances, and I venture to say that it will be through the judicious and more frequent applications of this instrument that material improvements both in the permanent way and in the rolling stock of electric tramways will be effected.

Probably the most interesting and complete tests with horse cars were those made by M. Tresca. He proved, experimentally, that the groove in the rail was the direct cause of a large portion of the resistance to traction. An ordinary car with its four flanged wheels was propelled over the tracks of the Paris-Versailles tramway, and it was found that the average tractional resistance amounted to $\frac{1}{100}$ of the gross weight, or 22.4 lbs. per ton. Subsequently two of the flanged wheels, both on one side of the car, were removed and replaced by flangeless wheels, when the resistance, all other things remaining the same, amounted to only $\frac{1}{147}$ of the weight, or 15¼ lbs. per ton. The gross weight of car and passengers was 5.67 tons. These experiments show conclusively that at least half the power is wasted in friction between the sides of the groove and the wheel flanges.

The force required to start a tram car and to get up speed is necessarily greater than the force required to maintain a given speed uniformly. It was found that the starting force is from four to five times that necessary for running on the level road. Curves also increase the resistance very much. In dry weather, on curves of 50 feet radius, the resistance to traction is doubled, and on those of 35 feet radius trebled; but when the rails are wet, this resistance, due to curvature, is considerably reduced. Water, plenty of water, on the rails acts as an efficient lubricant, and you will see by statements later on, the general effect of wet rails. Short wheel bases, bogies, or radiating axles, render motion on curved rails easier, and flexible axle boxes are now greatly favored, especially in the United States, for the same reason.

The effect of gradients is a matter of simple calculation. It is the maximum gradient on a given line which determines the size and power of the electric motor. Allowing 22.4 lbs. tractive force per ton, we should have to exert a pull of 134.4 lbs. with a six-ton car on a level road. This, at the rate of seven miles an hour, or 616 feet per minute, would give us 2.5 horse-power effective on the axles. If we have to overcome a gradient of 1 per cent., or 1 foot in 100, the resistance due to gravity will also be 22.4 lbs. per ton, therefore we shall require about 5 horse-power to pull this car up a gradient of 1 in 100. With a 2 per cent. rise the power will be three times as great as on the level, and, roughly speaking, each per cent. of grade demands as much energy as the propulsion of a given weight on a horizontal road if the speed is to be constant. On steep gradients, however, it is customary to run slower, whereby some of the energy is saved at the expense of time.

The time at our disposal will not permit of descriptions of particular systems of electric traction, nor of the relative merits of each, and we shall confine ourselves entirely to statistics on tractive force, no matter how this force is transmitted; and we shall merely consider the question of moving a given load on a given track by means of the electric current. In order to ascertain the amount of energy used on electric cars I have made, in conjunction with the Electric Car Company of America, a long series of systematic tests both on an experimental track built for this purpose, as also on the public roads under all sorts of conditions of traffic. Whilst on the experimental track we could run at any speed we liked, and without stoppages, on the public streets we were confined to the speed of horse cars in front and behind us, besides taking up and putting down passengers and regulating our vehicle to the general traffic of some of the busiest streets of Philadelphia.

This experimental track was laid in an irregularly shaped yard as shown on the diagram Fig. 1, and it was intended to represent as difficult a line as is likely to occur in actual practice. Its entire length was 1,005 feet, the ends being so joined that the cars could circulate continually. Five and a quarter journeys round this track represented a mile run. There were four curves, two of 50 feet radius, one of 33 feet and one of 100 feet. Tangent with the 33 foot curve was a gradient of 4.98 per cent. rise, which descended on the other side at the rate of 5.8 per cent., and joined the curve with a radius of 100 feet. On this track we carried out tests and recorded observations which may be counted by the hundred thousands. The following figures relate to experiments made with a car in the autumn and winter of 1887–1888. The vehicle was an ordinary 16 foot two-horse car, with two axles, one motor and a set of storage batteries. It weighed, with several men on board, 5.3 tons; its wheel base was 6 feet, and one axle only was driven by an electric motor with intermediate spur gearing.

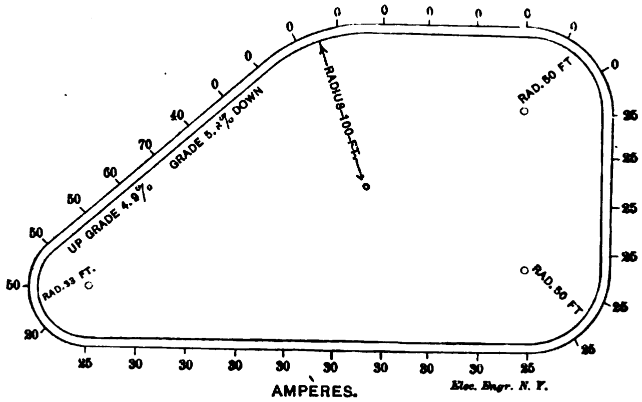

FIG. 1.

The rails were the ordinary American flat rails, grooved only at and near the curves, which represented a large percentage of the entire track. With a set of 84 cells of a nominal capacity of 150 ampere hours, this car made 230 trips round this track, representing an aggregate of 43.8 miles with one charge of batteries. The car was only stopped and started fourteen times. The actual running time was 6¼ hours, giving an average speed of seven miles an hour. At the commencement the electromotive force of the cells on closed circuit was 160 volts, and at the end 145.62 volts, the average from actual measurements was 157 volts. The maximum current used on the steepest grade was 70 amperes, at starting; on the curve or grade, it rose to as much as 120 amperes. The average current consumed was 22.6 amperes, which corresponds to 141 ampere hours taken out of the battery. The current on the level road fluctuated between 18 and 25 amperes. The diagram, Fig. 1, representing this track has marked upon it the current rates used at the various points of the journey. It will be observed that the car ran by momentum during a considerable portion of the journey, this momentum being acquired during its downward movement upon the 5.8 per cent. gradient, the brake being only slightly applied, and the stoppages during this experiment, as I have said, were few.

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[1] Paper read on Wednesday, April 30th, before the Old Students' Association of the City and Guilds of London Institute.

A mean of 4.75 electrical horse-power was thus expended, giving a consumption of 29.69 horse-power hours supplied by the battery; and the maximum energy given off at any moment was 10,500 watts, or 14 electrical horse-power. Allowing an average efficiency of 75 per cent. in the motor, and 85 per cent. in the gearing, we obtain a total efficiency of nearly 64 per cent. between the motor terminals and the axle, or about 3 horse-power available for traction. Thus the mean tractive force throughout the 43.8 miles run was 160 lbs., or about 30 lbs. per ton. This is very low, considering that out of the entire distance we had only 21 miles of tolerably level track, the rest being made up of 3.4 miles of 33 feet curves, 7.07 miles of 50 feet curves, 3.64 miles of 100 feet curves and 4.05 miles of ascending grades of 4.98 per cent. On the other hand, there were 3.8 miles of descending grades of 5.8 per cent. which furnished momentum right along the 100-foot curve until the car passed completely into the upper 50-foot curve on the right hand side of the diagram. Converting the work into ton-miles, which is probably the most rational way of comparing figures, we get 5.3 × 43.8 = 232.14 ton-miles at an expenditure of 29.69 h. p. hours, and this gives nearly 7.78 ton-miles per h. p. hour. We have obtained much better results than this with a subsequent car containing various improvements, and, on one occasion, this larger car made 68 miles on the experimental track, each h. p. hour producing 10.9 ton-miles, but these are exceptional feats, and our present object is to consider practical results corresponding with every-day work—industrial results in fact.

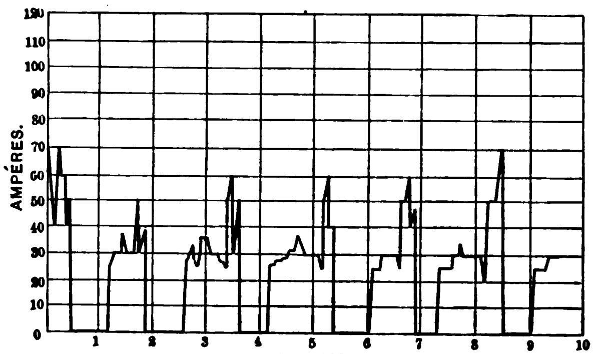
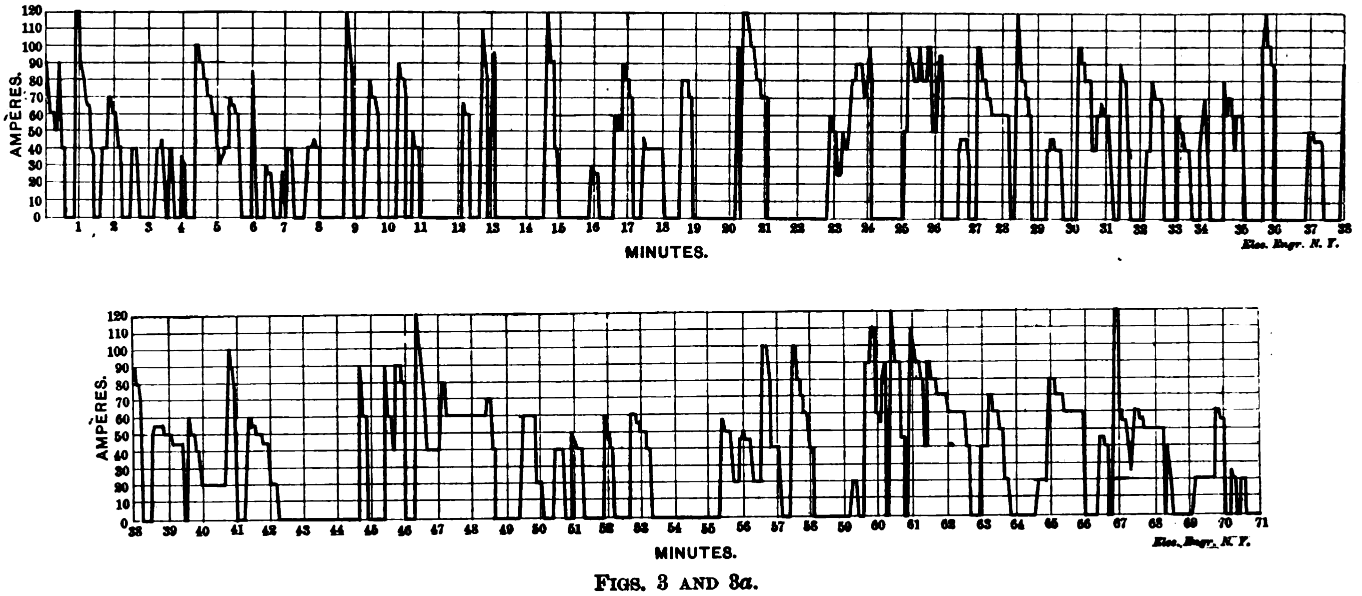


Fig. 2.

Three men, each well trained for his work, were necessary for these tests, and their respective duties were as follows:—One man took charge of the switch in front of the car and the hand-brake; in fact he performed the ordinary function of a driver, taking care that the car moved at regulation speed on the level, that it did not "race" down grades, nor go too slowly up the inclines, and that it took the curves with safety. The second man, with a timepiece in his hand counted the number of round trips and recorded the same; he also took voltmeter readings at equal intervals. The third attendant had the more difficult task of reading the deflections on the ammeter and writing down the values. In order to insure uniformity in the time between each reading, and also to take as many readings as possible, one has to learn to write down a certain number of figures in a given time, putting down ciphers, to fill up time when the ammeter needle is at zero. The number of observations written down during the 43 mile test were close upon 7,500, or one reading every three seconds. Considering the rapid variations in the current on uneven tracks, it is very important that readings are recorded at the shortest possible intervals in order to arrive at a correct average. The specific gravity of the cells was tested before starting, when they were fully charged, and it averaged 1.186. At the end of 6¼ hours, when the cells were practically discharged, the density fell to about 1.126. The accumulators were then recharged for 6 hours at the rate of 30 amperes, when the electrolyte assumed its original specific gravity. It is impossible to keep the acid in every cell at the same density; there are always slight differences, and we had to take the mean of the entire number of cells to insure accuracy. Diagram Fig. 2 represents the currents used during six journeys round the experimental track, and this was virtually repeated throughout the tests, except when stopping and starting. Now compare this with diagrams Figs. 3 and 3a, showing the current variations out in the crowded streets. You will observe a number of tall, narrow peaks running down to the zero line at frequent intervals. During these intervals the car was either stopping or running by momentum. The vertical lines in this diagram represent minutes and seconds, and the horizontal lines amperes measured on the car during the entire journey from 23d street to the Exchange in Philadelphia and back to the Graysferry depot, and from thence again to its starting point, a distance of about seven miles. Every corner on this diagram represents a movement of the switch by the driver.

The switch was constructed to throw the various distinct coils on the field magnets of the motor into parallel or in series, or into several intermediate steps, and these steps can be readily detected on the sharply defined junctions of the lines showing amperes. The average current consumed throughout this round trip, down town and back to the depot, amounted to 31 amperes. The weather was dry, windy, and the road very dusty. Allowing for this, as well as the frequent stoppages and slowing down in order to keep pace with the horse cars on the same line, it appeared that there must have been some waste of energy. The diagram shows that there was a continuous effort of getting up great speed at one moment and slowing down the next. It shows that the driver was somewhat nervous and inexperienced to driving in the public streets, hence the frequent alternate use of high currents and brake. The gradients on this road are not very severe; the heaviest is about 4 per cent., and several of 2 and 3 per cent. Calculating as before, and allowing the same efficiency, we should get an average tractive force of 39 lbs. per ton. The car in this case carried 23 passengers one way, and 30 on the return journey, giving a mean load of 7 tons.



Figs. 3 and 3a.

Numerous journeys were made through the city with this car, and some days after the above event I again took careful readings; the driver was more experienced, less nervous, never used the utmost electrical power at his disposal, and the average current during two round trips came to only 23.11 amperes. Twenty-five per cent less than formerly, under similar conditions of load, speed and weather. Although the average height of the peaks was less in this case, the number of them was nearly the same, and the gaps representing periods when no current was used gave, on being added up, 45 per cent. of the total. Thus for nearly half the time the car was running by momentum alone. It must be remembered that every few hundred yards there is a street crossing those we ran on, and all these streets have their tramways, so that for common safety it was necessary to slacken down at each square or block of buildings, even when other traffic and passengers did not impede our progress. These diagrams teach us two important lessons; one is, that a skilful driver can economize energy to a large extent; the other, that proper appliances for regulating the power within a wide range, are a distinct advantage.

After a good shower of rain the tram rails assume a tolerably clean appearance; the mud is then easily squeezed out by the flanges of the car wheels; thus I have observed that during. or immediately after a rainfall, the energy necessary for propelling a vehicle is considerably less than in dry weather. There is a positive saving of power amounting to from 15 to 50 per cent. with clean wet rails. By careful observations we were enabled to record the effect of various comparatively small obstacles on the rails; the ammeter showed the minutest variations in tractive force; it is far more reliable than a dynamometer, since it has neither friction nor momentum.

Snow is the greatest enemy of tramways; it offers the greatest resistance to traction. Anticipating snow storms, which occur rather frequently in some parts of the States, we fitted the experimental car with a snow plough and wire brushes. The plough shears were supported by a balanced frame underneath the front platform of the car. These shears could be raised and lowered by foot pressure. Behind the plough shears and just ahead of the front wheels of the car were brushes made of steel wire, and these were kept scraping over the rails by their own weight. The plough served the purpose of removing the bulk of the snow, and the brushes swept the rails and grooves clean in front of the wheel flanges. One day when it snowed very hard, and when the rails were covered about a quarter of an inch deep, we ran the car out upon the experimental track, using in the first instance merely the wire brushes and a little sand on the steepest gradient. It took 2 minutes and 8 seconds to run once round the track, which was soon cleared of snow, taking a mean current of 50 amperes. Snow fell hard all the time, yet it required only 35 minutes to make 20 successive trips, with an average of 30 amperes. In the course of four hours the snow was nearly 2 inches deep, when the car was again started. The brushes alone were of no avail, and the snow plough had to be applied. The first journey was made in 2 minutes and 20 seconds, but with the enormous expenditure of 80 amperes; each succeeding trip, however, took less time and energy, until it reached nearly to its normal value corresponding to clean rails. This would show that with proper appliances, and with cars rapidily scceeding each other, the track can be kept clear; but the accumulation of much snow in the first instance occasions a fearful demand of energy, and without plough and brushes the snow is compressed by the wheels and renders progress almost impossible.

Miles per hour.	Volts.	Amperes.	Electrical h. p.
7.5	404	9.5	5.15
9.3	416	10.4	5.79
9.1	393	10.7	5.40
10.9	434	16.1	9.35
12.4	433	15.4	8.93

Another test on a gradient of 6.58 per cent. rise, one-tenth of a mile in length, gave the following results:—

Miles per hour.	Volts.	Amperes.	Electrical h. p.
2.73	347	27.2	12.65
4.20	403	27.4	13.47
9.30	409	31.3	17.14
6.20	365	32.4	15.85

Recent tests made by a commission on the Frankfurt-Offenbach Electric Tramway, which has been in constant operation for six years, gave the following results:—Two cars, one of which contained the motor, the other an ordinary car attached to it, were taken over the line. The motor car weighed 4 tons, the ordinary car 2 tons, and 20 passengers 1½ tons, giving a total of 7½ tons. Measurements with an amperemeter were made every 5 seconds. The electromotive force varied between 240 and 300 volts. At starting the current used was 80 to 100 amperes, which fell to 40 in 10 seconds, and the mean current on the level road at 8 miles an hour fluctuated between 15 and 25 amperes. On a gradient of 2.85 per cent. 55 to 60 amperes were recorded, and the mean current over a distance of one mile occupying seven minutes was found to be 21.48 amperes, and this included four stoppages. The highest amount of energy recorded at any moment, when starting, was 21,700 watts.

Dr. Louis Bell, in an interesting paper published a few months ago, gave the results of his experiments on the Lafayette road (Ind.), from which I take the above instructive figures. Experimental runs were made on a level road with a car and passengers weighing together 8,200 lbs.

These results are remarkable when compared with those on the level road; considering the steep gradient, one would have expected a much larger consumption of energy at the necessarily low motor speed. On the other hand, the tractive force on the level road appears to be abnormally high at all speeds when the motor efficiency should be at its very best.

More recently Mr. O. T. Crosby published some interesting data concerning three American tramways which, like those of Lafayette, were worked by overhead conductors. The average expenditure of energy on one car on each of the following lines was:—

	Watts.	Electrical h. p.	Load.	Average speed.
Richmond	4,883	6.5	8,500	6 miles
Cleveland....................	4,986	6.6	9,500	9 "
Scranton.....................	5,587	7.4	9,500	5.7 "

The maximum gradients were given to be at Richmond 9 per cent.; at Cleveland "very slight;" and at Scranton 7 per cent., involving maximum expenditures of power of 25.6 h. p., 15 h. p. and 19.2 h. p. (electrical measurements on cars) respectively.

Dr. E. Hopkinson ascertained the mean tractive force on the Bessbrook-Newry Tramway, and he showed that it amounted to 28.9, 27.4 and 37.1 lbs. per ton of gross load hauled during three journeys. The increase in the third journey is due to the mean speed having been nearly doubled. The gradients are not severe in this case, but continuous in one direction.

From numerous sources at our disposal we find that the mean tractive force may be anything from 30 to 50 lbs. per ton, and that it is seldom, if ever, below 20 lbs. on level roads excepting under very favorable circumstances.

All these figures point to the fact that the mechanical resistances on existing tramways are very great, and that even a slight reduction at a comparatively small cost would bring about a considerable saving in traction expenses. By reducing these resistances we not only save power with existing appliances, but by virtue of a smaller demand of tractive force we are enabled to utilize lighter motors, lighter gearing, lighter storage batteries, which, in their turn, again require less for their own propulsion, until a practical limit is reached.

Assuming, *a priori*, high efficiency in electric motors and gearing, improvements as regards mechanical resistance on tramways may be looked for, and, I hope, attempted in the following points:

1. Solid, well fixed, parallel rails.
2. Perfect cylindrical wheels, with thin flanges, or some of them without flanges.
3. Clean rails. The grooves may be swept and watered several times a day by a vehicle especially fitted for this purpose.
4. Sufficient flexibility in axle boxes to allow of free movement in curves.
5. A reasonable number of graduations in the motive power regulated by a switch.
6. Skilful driving, which should occasionally be proved by careful tests and power curves.
7. Automatic sand boxes on steep gradients where the natural adhesion is insufficient.

In conclusion I will repeat that a frequent and judicious use of the ammeter on electric cars will amply repay you for the trouble; it will be the means of great improvements, in the same manner as the indicator diagram enabled us to study the nature of steam engines, and which has been the most direct means of effecting great economy in working.

COST OF A MUNICIPAL PLANT FOR MILWAUKEE, WIS.

The estimate of probable cost of an electric light plant (to be operated on municipal account by the city of Milwaukee, Wis.), as returned by the Board of Public Works in response to a resolution of Common Council, is as follows—the figures being based on a plant capable of maintaining 1,745 lamps of 2,000 candle-power each: 1,745 lamps, $47,115; 70,500 feet of conduit, $70,500; 6,393 poles. $22,375; 8,021 cross-arms, $1,764.62; 1,941 break-arms, $970.50; 18,000 wood pins, $540; 15,424 bolts, $462.72; 18,000 insulators, $1,440; 460 miles of wire, $84,000; 53 miles guy wire, $636; 257,650 feet of rope, $3,145.89; 5,331 pulley blocks, $2,398.95; 150 dozen lamp cleats, $375; setting poles, $6,393; cables in river crossings, $20,000; incidentals, $5,000; tools, $1,000; real estate, $20,000; buildings, $20,000; four 500 horse-power engines, $60,000; 14 boilers, $21,000; shafting, etc., $20,000; 55 dynamos, $55,000; 55 lightning arresters, apparatus, etc., $5,000; incidentals, $5,000; tools, $500; total, $575,442.18.

Mr. E. R. Weeks, the late president of the National Electric Light Association, is on a visit in the East on business and pleasure.

THE APPLICATION OF ELECTRICITY TO AGRICULTURE.[1]

BY N. SPECNEW.

ELECTRICITY has already been applied to numerous commercial purposes, and in this article I propose to study its influence on plants and its application to agricultural purposes. Ever since electricity has been a science its effect on the growth of plants has been the object of much research. The early investigations, however, resulted in contradictory results, which may be explained by the then imperfect state of electrical science, and by the embryonic conditions of its technical applications. It was owing to this state of affairs that Jolabert, Nollet, Mainbray, Achard, Berthollon, and Pardini Van-Marum, affirmed that electricity favored the development of seeds and accelerated the growth of plants; whilst Ingenhouse, Van Tootswyck, Sylvestre, Senebier, and, to some extent, Decandolle, categorically denied the influence of electricity. The experiments of the *savants* were evidently inexact, and were carried out in a too limited manner; though, on examining them more closely, we find manifest indications of the influence of electricity. Gradually, however, scientific investigations established in a definite manner the incontestable fact that electricity had a beneficial effect on vegetation. To this result the works of Sir Humphry Davy, Bischoff, Humboldt, Wollaston, and especially Becquerel, largely contributed. But these scientists only occupied themselves with the theoretical side of the question; and it is only since 1845 that the first practical experiments in electro-culture have been undertaken. At this date, side-by-side with barren attempts to utilize gigantic electro-static machines, as suggested by Williamson, we hear of the application of a current of electricity produced by two metallic plates, one of zinc and one of copper, placed in the soil, and united by a wire. This method was first employed in England in 1846 by Sheppard, then by Foster in Scotland, and in 1847 Hubeck in Germany surrounded a whole field with a network of wires. Unfortunately, the results of these experiments were published in terms too vague to be of much use. Sheppard came to the conclusion that his experiments showed that electricity only increased the return from root plants, while grass perished when placed close to the electrode. He also asserted that one-third of the plants which developed were inferior to those which had been under the influence of the electric current. According to Hubeck, seeds developed more rapidly, and buckwheat gave a larger return; but in all other cases the electric current produced no result. At the same date the experiments of Prof. Fife were going on in England, and those of Otto von Ende in Germany. These experiments gave negative results, and even led these scientists to advise the complete abandonment of attempts to apply electricity to agriculture.

After a long interval of time we have the investigations of Fichtner, who employed a battery, the two wires of which were placed in the soil parallel to one another. Between these wires, and parallel to them, peas, grass, and barley were sown, and in every case the crop showed an increase of from 13 to 27 per cent. when compared with the ordinary methods of cultivation.

These experiments, and a number of others, led me to investigate the influence of electricity on plants in every state of their development; but I will content myself in this article with describing only those experiments of practical interest.

I. This experiment showed that by submitting different seeds to the action of an electric current their development is rendered more rapid and more complete. I employed in these experiments seeds of haricot beans, sunflowers, winter and spring rye. In every case twelve groups, containing 120 seeds each, were taken and submitted to the action of the current. Twelve exactly similar groups were not submitted to the action of the current, but, with this exception, were treated in identically the same manner. Both lots of seeds were first plunged into water until they swelled. The seeds were then submitted to the action of the current in the following manner: When still wet they were introduced into long glass cylinders open at both ends. Two copper discs were introduced at either end, and were pushed in until they compressed the seeds. Rods attached to these copper discs were connected to the poles of an induction coil. The circuit contained an ammeter, and the current was kept on for one or two minutes; immediately afterwards the seeds were sown. The temperature was kept during the whole time that they were growing at 6° to 8° Réaumur (45° to 50° F.). These experiments were repeated ten times, and the results in the table are most striking. I have also to add that the plants which resulted from the electrified seeds were more developed; their leaves were far larger and their color brighter than in the case of plants resulting from the non-electrified seeds. The current had no effect on the yield.

——	Peas.	Beans.	Barley.	Sun-flowers.
Electrified seeds developed in..	Days. 2.5	Days. 3	Days. 2	Days. 8.5
Non-electrified seeds developed in............	4	6	5	15

II. A second series of experiments was carried out with large plates (.445 metre × .712 metre) of zinc and copper which were placed in the soil at the ends of the plots, the rods connected to their upper faces being united by a wire. This disposition was, therefore, equivalent to a battery (zinc | earth | copper), the current of which passed from one plate to the other through the ground. This method was applied more especially to pot herbs and flowering plants. The experiments were carried out at the Botanical Gardens at Kief. The influence of the current was manifested by a larger crop and by the growth of vegetables of enormous dimensions.

III. In a third series of experiments the idea was to apply electricity on a large scale, and current electricity was replaced by static electricity. These experiments were carried out on a site situated in the government of Pskow. In order to understand them better, it is necessary to remember the effect which has been established by experiments, viz., that the slow discharge of static electricity facilitates the assimilation of nitrogen by plants. It is for this reason that plants which are grown in a Faraday metallic cage contain 50 per cent. less organic matter than the plants which are grown in the open air.

On the different plots of earth sown with different seeds (see table below) we placed insulating rods, at the top of which were placed collectors, shaped like crowns. All these collectors were united by means of wires. Atmospheric electricity was thus collected above the seeds, and they matured in the midst of a highly electrified atmosphere. The results of this form of electro-culture are shown in the table. The figures give the averages of five years. All the plots between which comparisons are made were under identical conditions. These figures show, indisputably, that there is a considerable increase in the yield, whether of seed or straw; it was also observed that ripening was more rapid, especially for barley, which, in many instances, ripened twelve days sooner with electro-culture. Another important phenomenon was also observed. Potatoes were seldom diseased when grown by electro-culture; instead of 10 to 40 per cent. of them being bad, only 0 to 5 per cent. were so. These properties of electricity deserve all the more attention, since there are experiments which prove the beneficial effects of electricity on vines attacked by phylloxera. The enormous importance of these facts is self-evident; they seem to offer a new means of combating the microscopic diseases which attack vegetable growth.

A very practical question is—how much does electro-culture cost? I am only able to give the cost of experiments undertaken by myself. The cost of the two metallic plates in Experiment II. is about $4. The installation of these plates does not require much time nor much technical knowledge, and it must be remembered that once *in situ* the plates are good for several years. The electro-static experiment No. III. was more costly, since it was necessary to have from 50 to 60 insulated rods per dessatin (2 acres). Each collector costs about $2. But in this case also the expense once incurred the installation lasts for some time. I trust these experiments will be repeated on a still larger scale, and that some day we shall see electro-culture assume large proportions.

Plants.	Quantity of seed sown, in funts.	Mode of culture.	Crop per dessatin.		Percentage gain due to electro-culture.		
			Seed in funts.	Straw in funts.	Seed vol-ume.	Seed weight.	Straw weight.
Rye....	480	Ordinary......	2,565	5,600	128	128	160
		Electro-culture.	3,280	8,960			
Corn....	480	Ordinary......	2,560	5,000	156.3	156.1	108
		Electro-culture.	4,000	5,080			
Oats.....	630	Ordinary	3,045	3,800	157.4	161.6	154.7
		Electro-culture.	4,932	6,000			
Barley...	430	Ordinary......	2,064	5,000	148	155	117.8
		Electro-culture.	3,195	5,880			
Peas.....	500	Ordinary......	3,760	5,200	122.5	122.3	128
		Electro-culture.	4,692	6,400			
Clover...	50	Ordinary......	880	10,400	232	231	117.8
		Electro-culture.	2,040	12,200			
Potatoes.	3500	Ordinary......	35,000	3,600	111.3	111.4	133.8
		Electro-culture.	39,000	4,800			
Flax....	320	Ordinary	1,600	12,360	142.3	147.2	111.4
		Electro-culture.	2,300	14,360			

NOTE.—1 funt = .9 lb.; 1 dessatin = 2 acres (approximately).

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[1] *La Lumière Electrique.*

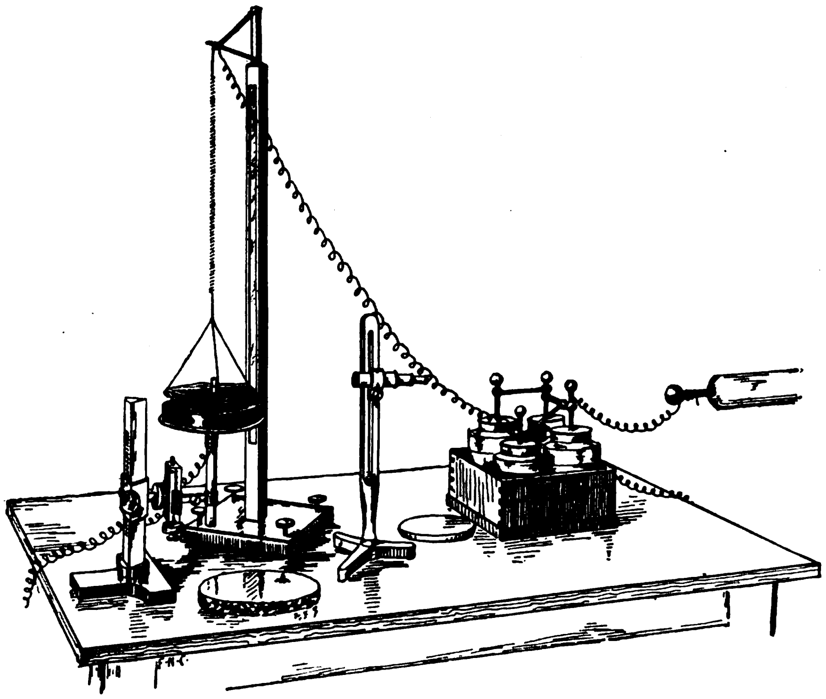
ON A LARGE SPRING-BALANCE ELECTROMETER FOR MEASURING (BEFORE AN AUDIENCE) SPECIFIC INDUCTIVE CAPACITIES AND POTENTIALS.[1]

BY PROF. ALFRED M. MAYER.

THIS apparatus was devised by me for showing to my classes the general phenomena of induction through various dielectrics, and for making approximate measures of their specific inductive capacities. These phenomena and measurements are rarely shown to students, and when their exhibition is attempted the actions on the apparatus used are generally too minute to be seen by a class, and hence the measures deduced from these actions are unsatisfactory.

The apparatus here described has done excellent service during five courses of lectures. Its chief characteristic is that it shows *directly*, and not inferentially, that different dielectrics transmit the force of electricity in different degrees.

The engraving gives a general view of the apparatus. A helical spring, made of brass wire of .012 in. diameter and with 800 turns, is supported by a bracket formed of rods of glass. These rods were dried by heating in a gas-flame and while hot were coated with paraffin. To the lower end of the spring is suspended a disc of thin mica 16½ cms. in diameter, silvered on its upper and lower surfaces in a silvering solution. This disc, which was nearly flat, was made rigid and as nearly flat as possible, by cementing (under pressure) to its upper surface nine light and straight rye straws. Six of these formed chords of 60°, the other three formed an equilateral triangle included by the hexagon. This prevents flexure of the plate when it is suspended at three points by the fine wires shown in the figure. This silvered disc is surrounded by a guard-ring supported on three paraffined glass rods. The ring and rods are not shown in the figure.


LARGE SPRING BALANCE ELECTROMETER.

Under the silvered disc and parallel to it is a brass plate connected with the earth, and movable up and down by means of a rack and pinion and a micrometer-screw. In ordinary work before a class the micrometer-screw is not required. The *difference* only between the distances of the earth-plate from the mica-disc is required in the measurement of specific inductive capacity, and this difference can be measured accurately enough by means of a millimetre scale cut on the column of the support of the earth-plate.

A tube of thin glass is cemented at the centre of the top of the mica-disc. On this tube is pasted a piece of paper with a fine line drawn on it parallel to the disc. Through the telescope on the right we sight on a horizontal thread this line, and when the apparatus is charged we can then always depress the mica-plate to the same level, and with the same force, by gradually raising the earth-plate.

The helical spring is connected with the Leyden battery, which latter is charged with + electricity from an electrical machine. To insure a constant charge during the two measures required to determine a specific inductive capacity, a simple torsion-balance carrying a gilded pith-ball is repelled by a similar ball at the end of a rod connected with the battery. A pointer on the torsion-rod moves over a graduated arc.

To show the general phenomena of the action of a dielectric compared with air, we charge the apparatus and bring up the earth-plate till the mica-disc is sensibly depressed by the attraction existing between it and the plate connected with earth. The disc of the dielectric is now slid on the earth-plate, when every one sees a considerable depression of the mica-disc by the increased force between the two plates through the intervention of the dielectric. Or, we may reverse the operation, and first place a dielectric on the earth-plate, then slowly raise this plate, with the dielectric, till the attraction between earth-plate and disc has caused the latter to be depressed so far that it is just above the point from which it would descend to *contact* with the dielectric. Now suddenly slide the dielectric from the earth-plate. The disc at once rises through a considerable distance, which is distinctly visible throughout the lecture-room. In the case of a glass disc 2 cms. thick this upward motion may amount to 3 cms., and after a few oscillations the mica disc comes to rest at a distance of about 1½ cm. above its previous level.

To show the "electric absorption," "residual charge," "permeability," or "dielectric afterworking" (Boltzmann) of a dielectric we use a disc of parafin. With this on the apparatus we raise the earth-plate till the mica-disc is sensibly attracted, and is stationary. This condition, however, only lasts for a short time. Soon the disc begins to descend, and after a minute or two has come near the paraffin, to whose surface it now rushes. It cannot now be detached till the battery has been discharged, or the earth-plate has been lowered so much as to unduly stretch the spring.

This experiment presents clearly a fact long known, that, with the exception of sulphur, all dielectrics, and especially paraffin are "permeated," or "polarized." in the condenser by time-action of induction, and so is increased the attraction existing between the plates. Boltzmann[2] shows from his experiments that with times of inductive action lasting $\frac{1}{360}$ to $\frac{1}{64}$ sec., $\frac{9}{10}$ sec., $1\frac{3}{10}$ sec., and 45 secs., the specific inductive capacity of paraffin is respectively 2.32, 2.51, 2.56, and 8.12. Schiller's[3] experiments show that for times of charging plate-glass in the condenser of $\frac{1}{20000}$ and $\frac{1}{25}$ sec., the specific inductive capacity is respectively 5.83 and 6.34, or an increase of 9 per cent. in .03995 of a second. Wüllner[4] gives these conclusions from his experiments on the subject: "The instantaneous capacity (that is, the capacity when the charging lasts for a very small fraction of a second) is of quite a different nature to that capacity which increases slowly as the electrification continues. The 'instantaneous capacity' is independent of the conductivity—the 'slow capacity' is not."

To measure the specific inductive capacity of a substance, we place the guard-ring around the mica-disc. This ring has projecting from the edge of its circular opening three short fine wires, so adjusted that when the mica-disc rests on these wires the lower surfaces of disc and guard-ring are in the same plane. The apparatus having been charged, the dielectric is introduced and the earth-plate is raised till the mica-disc is attracted so that it rests on the three wires of guard-ring. The plate is now very slowly lowered till the tension of the spring just exceeds the attraction of the plates, when the disc suddenly rises. The scale reading on the support of the earth-plate or of the micrometer-screw is read. The dielectric is now removed and the disc brought down on the wires by raising the earth-plate, and then by lowering this plate the disc again leaves the wires, and the corresponding scale reading is taken. From the *difference* of the scale readings the specific inductive capacity is determined, as follows:

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[1] *American Journal of Science.*

[2] *Wiener Sitzungsber.* Bd. lxviii, 1873.

[3] *Pogg. Ann.*, 152, 1874.

[4] *Sitzungsb. königl. bayer. Akad.*, 1877.

Let the scale reading when only air is between the plates be s; when the dielectric is introduced, s_1; then $s-s_1$ is the distance the earth-plate has been moved so as to give in the two experiments the same force of attraction on the mica-disc. A dielectric of thickness t and specific inductive capacity K equals in capacity a condenser with a thickness of air between plates equal to $\frac{t}{K}$. Now when we introduce the dielectric plate it replaces a thickness of air, t. So the effect of introducing the dielectric is to increase the electric capacity of the apparatus as if we had brought the earth-plate and the mica-disc nearer by this distance t and then farther apart by the distance $\frac{t}{K}$, which is the same as if we had diminished the distance between the earth-plate and disc by $t - \frac{t}{K}$. But as in the two experiments the force on the mica-disc is equal, we must have caused an equal *decrease* in *capacity* by increasing the distance between earth-plate and disc by the quantity $s_1 - s$, when the dielectric intervened, and this *measured* increase of distance equals the imaginary decrease of distance produced by the dielectric, and we have $t = \frac{t}{K}(s_1 - s)$ and $K = \frac{t}{t-(s_1-s)}$.[5]

We use a disc of sulphur about 2½ cms. thick as the body to experiment on in this measure before a class, as sulphur is very slightly, if at all, affected by time induction during the interval occupied by the measure.

If the guard-plate be removed the phenomena become more apparent to the audience, but the measure is not so exact. In making measures without the guard-plate we use the telescope and the line on the glass tube, or, for ordinary qualitative illustration, a pointer may replace these.

It need hardly be stated that measurements with this apparatus are of little value when compared with the measures made with the excellent apparatus of Gordon where entire control of the time of charging, and means of measuring, very minute differences of capacity are used. Nevertheless the measures obtained with this apparatus are really more reliable than those obtained by some of the older experiments. The exhibition of the actions of this apparatus, however, are well worthy of being shown to students. The clear ideas and lasting impressions they give, from their directness and easy comprehension, will reward the teacher for the time he may give to the construction and use of the apparatus.

The same instrument will also measure potential, for it is really a huge and rough absolute electrometer. Certain precautions are, however, needed in its use in such measures. In the formulæ used in measurements with the absolute electrometer,

$$V = D\sqrt{\frac{8\pi W.g}{A}}; \text{ or } V - V' = (D-D')\sqrt{\frac{8\pi\ W.g}{A}},$$

one might suppose that W could be determined for the spring-balance electrometer by merely adding the weight in grams required to depress the silvered disc down to the level of the guard-plate; but, on electrifying the helical spring, its coils separate by mutual repulsion and a certain lengthening of the spring results. This action may be determined and allowed for by first ascertaining the weight of mica-disc and its wires and additional weight required to depress the disc to contact with the wires of the guard-plate. The disc is now detached from the spring and placed on the guard-plate wires. On the top of the disc is a tube, in electrical connection with the disc, and containing mercury. The earth-plate is at the position it has when we are measuring potential. The spring is so stretched by a weight that the straight end of its wire dips into the mercury in the tube on the mica-disc, and the apparatus is charged to the same potential it has when we are making a measure of that potential. We now ascertain the weight required to stretch the spring to the same extent it was stretched in the previous experiment. The difference in weight required in the two experiments gives the repulsive action of the electricity on the spring. This correction, however, is not precise, for the wire at the end of the spring is slightly pushed upward by the mutual action of the electrified wire and mercury.

Stevens Institute of Technology, Hoboken, N. J.

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[5] See Gordon's "Electricity and Mag.," vol. i, p. 111.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

A PIONEER ELECTRIC RAILWAY PATENT.

[128]—In Kapp's "Electrical Transmission of Energy," revised edition, under the head of the Evolution of the Electric Railway, reference is repeated to the patent granted to Henry Pinkus in the year 1840, by the United States Patent Office. This is an error. Mr. Kapp is very good to credit an American with the origin of the idea, but it seems to belong to an Englishman. The passage should read "British" instead of the United States Patent Office.

Some of the readers of THE ELECTRICAL ENGINEER, may be interested to know the electrical details of those patents. In March, 1884, Henry Pinkus was allowed a patent in England for a "Railway System." One of the forms consisted of a closed conduit between the rails. Within the conduit a piston traveled under the influence of an air exhausting pump driven by a stationary steam engine. The traveling piston carried permanent magnets within the sealed conduit, which were intended to attract other magnets carried on the car on the surface. This is the earliest reference to the use of magnetism in any mechanical form recorded in the British Patent Office.

The next reference is in June, 1887, when Thomas Davenport, one of our own countrymen, patented in England an electric motor. In November, 1839, William Taylor patented an improved electric motor. In September, 1840, Henry Pinkus patented improvements in "Pneumatic Railway Propulsion." Among his many suggestions is one in which electric batteries are placed in wells or tanks below the surface. Sectional conductors leading therefrom are exposed between the tracks and a traveling contact is maintained between the stationary batteries and an auxiliary electric motor, which is carried on the steam locomotive. The object of this auxiliary electric motor was to enable the superintendent at a distant point to blow the whistle, apply the brakes or shut off steam by interrupting the current. The troublesome part comes in where in this patent Pinkus incidentally suggests that "Taylor's rotary wheel" or any other electro-magnetic engine may be used as the moving power on a locomotive engine by taking up the electric force from the wires laid down between the rails.

JNO. C. HENRY.

New York City.

STEAM VS. ELECTRIC LOCOMOTIVES.

[129.]—Some time ago I read with interest Dr. Louis Bell's excellent paper on steam traction as compared with electrical traction, and consider it one of the fairest articles on the subject yet published. In the issue of THE ELECTRICAL ENGINEER for May 14, Mr. John C. Henry endeavors to prove this excellent paper erroneous, with but little success, however, where the reader of his article has any knowledge of locomotive construction and performance.

Mr. Henry's paper is very fair in one thing and in one only, and that is, his figures of coal consumption. While having no reliable data at hand I should be satisfied to accept his coal figures in preference to Dr. Bell's as an *average* consumption, though not doubting that Dr. Bell may be right under favorable circumstances; but I wish his figures might have been taken from some standard engine or the English compound on the Pennsylvania R. R. instead of that engineering monstrosity, the Strong locomotive.

The rest of Mr. Henry's article in regard to the locomotive seems to me to be based on an entirely erroneous conception. No one attempts to compare the locomotive and the stationary engine where the question of economy is concerned, for their conditions are so entirely different as to make comparison a farce.

The stationary engine is bedded on a solid foundation of masonry, well housed, free from dirt and flying sand, with abundant steam supply and in perfect alignment, which materially reduce friction of moving parts. The locomotive on the other hand frequently has an uneven track for a bed, its working parts exposed to rain and sand, and very often has to "run for steam," that is, favor the fire at the expense of economy. Again, it is hardly ever in the same alignment for two consecutive minutes, being varied as the drivers roll over frogs, rail joints or similar depressions or obstructions; and yet, notwithstanding these unfavorable conditions, is often run at a piston speed exceeding the best of stationary engines. As an example we may take the "Bound Brook's" 89.6 miles in 85 minutes.

While there is no comparison in the economy of the two it is hardly fair to misstate so many points concerning the "living monuments to nameless thousands of students." To deal with the subject properly the locomotive's cut-off does not depend on manual operation, any more than does that of the stationary engine, but upon the eccentric. The only difference is that the engineer is the locomotive's governor instead of the ball or fly-wheel governor of the stationary engine, and the only manual work is in *changing* the cut-off to suit conditions. The cut-off is just as automatic as in any stationary engine, being performed by valve gear in much the same manner as the Porter-Allen stationary engine. I wish it understood that I am speaking of the standard link valve gear of railroad use to-day, and not any of the grasshopper affairs that save 116 per cent. of fuel every day.

Locomotive valves are not of necessity *slide* valves, nor are they necessarily on top of the cylinder, "owing to peculiar construction;" if Mr. Henry will call on me I shall be pleased to show him drawings of many foreign engines, as well as domestic ones of older date, with valves on the side as well as on the bottom. Nor are *slides* necessary; the Baldwin compound engine, now on the B. & O. R. R. has piston valves. As for having "full weight of steam pressure against their movement," nothing could be more incorrect; all standard engines, or nine-tenths at least, have balanced valves equal to any stationary valve.

The locomotive boiler probably does not give the most economical results, but when such concerns as the Calumet and Hecla Mining Co. use that type for stationary work, it gives the impression that there are worse boilers made.

The balancing question is the last that needs some correcting, and here is another glaring error, for the Baldwin Locomotive Works always test their engines by jacking up the frame and running the drivers in air and then balance to run steadily. Mr. Cloud (not McLoud) of the Pennsylvania R. R. did investigate the "hammer blow" question and found an *apparent* blow of 9 tons instead of 60 as Mr. Henry states, but this question is not considered by the majority of railroad men to amount to very much in practice; surely not when a locomotive is perfectly balanced, though perhaps very few are perfect.

No one denies that the rotary motion of the electric motor is to be preferred to the reciprocating motion of any steam engine, locomotive or stationary, and no one is more friendly to its adoption wherever practical, than the writer. But what is objectionable is the continued misstatement regarding steam engines and the unwarranted claims that so many make for the electric motor and similar appliances. Such statements not only cause the steam engines to be underestimated, but any one familiar with steam is apt to distrust the writer and his cause as well, who makes such bold assertions. There is nothing gained by claiming everything; it savors too much of the patent medicine advertisements, and gains no friends.

Another point against electric motors, for trunk railway service, is their first cost. Supposing the cost of running and maintenance the same, it is much higher than that of steam locomotives of the same power, and this alone would debar them, other conditions being equal.

The *Railway Review* for May 31, has a very good editorial on this subject which all interested might read with profit, for one can learn much from the criticisms of others.[1]

That electricity is destined to play an important part in many of our great enterprises, there is no doubt, and none will welcome it more than I, but sometimes its enthusiastic friends do it more harm than good, and it is to promote a spirit of fairness that prompts this communication. Acknowledging the enemy's good points and then setting to work to excel them, is the best and safest way to progress.

FRED. H. COLVIN,

Philadelphia, Pa.

CORRESPONDENCE.

BOSTON.

Bell Telephone Dividend.—Eastern Electric Cable Dividend.—Boston Has Power to Light City Hall.—Debenture Bond Company.—Judicial Court on Municipal Lighting.—Providence Electric Subways.—Reception to Capt. Meigs.—Meigs Location in Boston.—Charges of Corruption in Legislature on Elevated Railroad Bills.

THE American Bell Telephone Company has declared a regular quarterly dividend of 3 per cent., and an extra of 6 per cent., 9 per cent. in all, payable July 15th to stock of July 1st. The books reopen July 16th.

The Eastern Electric Cable Company has declared a semi-annual dividend of 3 per cent., payable June 16th.

The Corporation Counsel has reported to the City Council that in his opinion the city of Boston has the power to make or provide electric light to furnish light for the City Hall, the Court House and the Registry of Deeds.

It is reported that Messrs. Kidder, Peabody & Company have decided not to interest themselves in the proposed Thomson-Houston Debenture Bond Company, but Messrs. Lee, Higginson & Company will go on with the formation of the company alone. The deposits of the common stock have reached about 173,000 shares out of a total of 180,000.

The justices of the Supreme Judicial Court sent to the house last week, a communication which was read by the clerk, expressing their desire to be excused from giving an opinion on the order adopted May 27, as to whether cities and towns have the right under existing laws to manufacture gas or electric light for use in the public streets and buildings, or for sale to the citizens of such cities and towns. In making this request the court believes the occasion has not arisen contemplated by the constitution in which its opinion may properly be recognized, since the question proposed affects only the construction of existing statutes which the legislature can amend or repeal as it sees fit.

The Mayor of Providence has vetoed the bill authorizing the electric light company to build an electric subway for electric light and power wires. This complicates the overhead question again, and it may be some time before the electric light company can be induced to make any more overtures towards burying their wires.

Captain J. V. Meigs, was tendered a reception at the Board of Trade rooms, in Lowell, Mass., by a number of his friends, in honor of the passage of the bill by the Legislature, granting him a charter for his elevated railroad system in Boston. In returning thanks for the reception Captain Meigs stated that he believed there would be no difficulty in getting money to construct the road. The Meigs' Elevated Railroad Corporation has applied to the Boston Board of Aldermen for locations from Sullivan Square, Charlestown, to Jamaica Plain, and for stations along the route.

A cyclone has struck the Legislature committee on elevated railroad bills, in the shape of charges by Mr. Williams, of Dedham, as to improper methods having been used in connection with the passage of the West End bill. A special committee has been appointed and a sweeping investigation is being made, the West End and Mack bills being tabled meanwhile.

The Senate has sent to the next general Court, the house bill authorizing cities and towns to supply themselves with gas and electricity.

BOSTON, June 14, 1890.

PITTSBURG.

Electric Railway Work—The New Telephone Exchange—A Successful Local Company.

The rumor is once more current in the local press that the Pittsburg and Manchester and the Pleasant Valley Electric Railway Companies are about to consolidate. These two corporations control the entire street car lines of Allegheny City, and their consolidation would create a very profitable monopoly of all the street car travel in the "City of Parks."

The Duquesne Traction Company has secured the location of its power house and ground will be broken for the erection of the structure within a few days.

The anti-induction telephone appliance to counteract the noise of the streets and thus make the telephone more powerful has for the first time been introduced in this city at the Eleventh ward police station.

The Johnstown Electric Street Railway Company is laying a double track on Main street, Johnstown, Pa., and expects to have electric cars running thereon not later than the first of next July.

The gas committee of Allegheny City met on the evening of June 11 and the curious fact developed that the contracts for lighting the city did not include the electric building itself. Then the fathers of the city wagged their heads in affected wisdom and ordered the superintendent to have the building wired for lights.

The Central District Telephone Company, which has for years complained of being greatly cramped for room in its present quarters in the First National Bank building, has at last found a new location. The company concluded the purchase of a very handsome piece of property on Seventh avenue a few days ago, and it is the intention to erect a magnificent seven story building on the acquired site.

The Citizens' Electric Light Company, of Braddock, illustrates its successful career by the announcement that it will shortly erect a new electric light station, which is to be the finest in Western Pennsylvania. When the building is finished the company will also add two more boilers, one 125 h. p. engine, a 50 light arc dynamo and a 750 light incandescent machine. The Westinghouse alternate current apparatus is being operated in this plant.

PITTSBURG, June 14, 1890.

MR. GUIDO PANTELEONI, the general Western representative of the Westinghouse Electric Co., has closed contracts for Westinghouse Electric Railway equipments at Springfield, Mo., and Pittsburg, Kan.

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[1] For a comment on this article, see THE ELECTRICAL ENGINEER, June 11, p. 443.

REPORTS OF COMPANIES.

WESTERN UNION QUARTERLY STATEMENT.

The statement of the Western Union Telegraph Company for the quarter ending June 30 shows:—Net earnings, $1,750,000; increase, $300,000. Surplus April 1, $9,590,916; increase, $1,193,718. Total, $11,340,916; increase, $1,493,718. Interest and sinking fund, $243,143; increase, $33,143. Balance, $11,097,773; increase, $1,360,575. Dividend, 1¼%, $1,077,382. Surplus, $10,020,377; increase, $1,460,561.

ANNUAL MEETING OF ERIE TELEPHONE.

The annual meeting of the stockholders of the Erie Telegraph and Telephone Company was held in New York on June 11, and the old board of directors were chosen, as follows: Abner S. Adams, Charles E. Adams, Charles J. Glidden, Francis Jewett, J. W. C. Pickering, Levi Sprague and Asa C. Russell, of Lowell, Mass.; Wesley A. Gove, of East Boston; W. J. McKinnie, of Cleveland, O.; James A. Weston, of Manchester, N. H.; Harvey A. Whiting, of Wilton, N. H. The directors organized by the choice of Levi Sprague, president; Charles J. Glidden, secretary and treasurer, and J. P. McKinstry, general manager. At the annual meeting of the Southwestern Telegraph and Telephone Company the same officers were elected, with the exception of Mr. McKinnie, and in addition John E. Hudson and Gen. Thomas Sherwin as directors, the latter representing the interests of the American Bell Telephone Company.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

In accordance with an agreement between the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, the headquarters of the Institute will be hereafter at the House of the Mechanical Engineers, 12 West 31st street, near Fifth avenue. Communications and exchanges should be addressed accordingly. The Secretary's office will be in the front room on the third floor. The joint library and reading room on the second floor. The auditorium, in which the meetings of the Institute in this city are to be held hereafter, is on the first floor. The entire premises are being renovated, and during June the Secretary's office will be temporarily located on the second floor.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

The annual convention of this great engineering body will be held at Cresson, Pa., a beautiful resort up among the mountains, on the Pennsylvania Railroad, 102 miles east of Pittsburgh. The hotel rate will be $3 per day. The convention begins on June 26, and will last several days. President W. P. Shinn will deliver an annual address, and a large number of professional papers will be read.

LEGAL NOTES.

THE KEMMLER CASE.

A special dispatch from Albany says: "The next legal step that will be taken by the Westinghouse Electric Company to prevent the use of their dynamos for the execution of murderers in this State will be in the form of a writ of replevin to repossess themselves of the three dynamos of their patent now in the State prisons at Auburn, Dannemora and Sing Sing, which Harold P. Brown, the electrical expert, purchased for the State. The Westinghouse Company claim to retain proprietary interest in the dynamos they sell (or claim merely to lease) to customers, after the manner of the Bell Telephone Company in leasing telephones, and will seek by action to restrain the State from employing them for purposes of execution by claiming that Brown illegally and fraudulently obtained possession of them by collusion with its customers having a leasehold possession of the dynamos in question."

DOUBLE CARBON LAMPS.—BRUSH ELECTRIC CO. *vs.* THE SPERRY ELECTRIC COMPANY. IN CHANCERY.

In the Circuit Court of the United States for the Northern District of Illinois.

Present: Hon. WALTER Q. GRESHAM, Circuit Judge, and Hon. HENRY W. BLODGETT, District Judge.

THIS cause having been brought to a hearing upon the motion of the complainant upon the bill and affidavits for a preliminary injunction to restrain the defendants, the Sperry Electric Company, from infringing complainant's letters patent, No. 219,208, granted to Charles F. Brush, September 2, 1879, and assigned to complainant, by making, using or selling double carbon lamps embodying the invention or inventions of said patent, and having been argued by H. A. Seymour, for complainant, and F. W. Parker, for defendant, and the same having been duly considered, the court finds as follows, to wit:

1. That the double carbon lamps manufactured by the defendants, the Sperry Electric Company, and produced before the Court, viz: Ex. 1, marked "Complainant's Exhibit, New Sperry Double Carbon Lamp," wherein the two pairs of carbons are independently actuated and adjusted and burned successively, the feeding carbon of one pair having a supplemental clamp or device whereby it may be manually latched up and retained, separated from its mate during the burning of the other pair, the latched-up carbon being then automatically released, and the arc established and maintained between the second pair of carbons until consumed; the other lamp, the construction of which is shown in defendant's drawings numbered 7 and 8, and wherein the two pairs of carbons are independently actuated and controlled, and burned successively, and in which the feeding carbon of the idle pair is required to be manually latched up, to insure such successive burning of the two pairs—each embody the invention of Charles F. Brush, as described in said Letters Patent No. 219,208, and specified in the first six claims thereof, and that the complainant is entitled to an injunction as prayed for, restraining the defendant company from manufacturing, selling or using either of such infringing lamps until the final hearing of this cause.

It is therefore ordered, adjudged and decreed, that the defendant, The Sperry Electric Company, its officers, agents, attorneys and employees, be, and they are hereby enjoined until the final hearing of this cause, from directly or indirectly making, selling, offering for sale, or using any double carbon lamps, like or similar to those mentioned in the finding above set forth, or any arc electric lamps in which two or more pairs of carbons are independently adjusted and regulated, and are burned successively to secure the continuous burning of one pair of carbons prior to the establishment of the arc between the other pair, substantially as set forth and claimed in the first claim of Letters Patent, No. 219,208, and also from making, using or selling any electric arc lamps containing the inventions set forth and claimed in the Second, Third, Fourth, Fifth and Sixth Claims, or any of said Claims in said Patent No. 219,208, this order and decree to take effect on and after July 3d, 1890.

W. Q. GRESHAM, H. W. BLODGETT,
District Judge.

INVENTORS' RECORD.

Patents issued June 10, 1890.

Alarms and Signals:—*Electric Annunciator*, J. D. Bishop, 429,599. *Electric Burglar Alarm*, H. C. Shubert, 429,817. *Water Indicator for Boilers*, J. J. Campbell, 429,997.

Conductors, Conduits and Insulators:—*Cable Terminal*, J. C. Reilly, 429,815. *Pipe*, J. P. Culver, 429,844. *Underground Electric Conduit*, H. Flad, 430,010. *Method of Making Glass-Lined Pipe Fittings*, D. Rylands, J. Crowder and R. Morant, 430,041.

Distribution:—*System of Electrical Distribution*, E. M. Bentley, 430,060.

Dynamos and Motors:—*Generator for Electrically-Reciprocated Tools*, H. N. Marvin, 429,729 and 429,732. *Electric Drill System*, H. N. Marvin, 429,730 and 429,731. *Dynamo Electric Machine*, R. Pfund, 429,736. *Electric Regulator*, E. Wagemann, 429,825. *Machine for Turning Dynamo Commutators*, H. G. McLean, 429,946.

Galvanic Batteries:—*Galvanic Battery*, J. Beattie, Jr., 429,596. *Galvanic Battery*, J. Silicio, Jr., 429,708. *Galvanic Battery*, G. H. Felt, 429,895. *Electrode for Galvanic Batteries*, G. H. Felt, 429,896. *Porous Cell for Galvanic Batteries*, G. H. Felt, 429,897. *Solution for Galvanic Batteries*, G. H. Felt, 429,898. *Galvanic Battery*, C. A. Hitchcock, 430,075.

Lamps and Appurtenances:—*Manufacture of Incandescent Electric Lamps*, R. N. Dyer, 429,608. *Electric Arc Lamp*, C. Coerper, 429,787.

Measurement:—*Electric Meter*, J. H. Barnard, 429,751. *Galvanometer*, A. E. Colgate, 429,887.

Metallurgical:—*Method of Separating Ores Magnetically*, C. M. Ball, 430,068.

Miscellaneous:—*Lightning Arrester*, O. J. Lodge, 429,727. *Graphophone*, J. H. White, 429,827. *Switch-Board*, J. M. Anderson, 430,054. *Key-Board Self-Playing Attachment*, J. D. Case and C. W. Evans, 430,065. *Electric Piano-Playing*, J. D. Case and C. W. Evans, 430,066. *Automatic Electric Cut-out*, M. Waddell, 430,096.

Railways and Appliances:—*Electric Railway*, R. M. Hunter, 429,687. *Electric Connection*, C. J. Van Depoele, 429,745. *Electric Railway-Motor Truck*, C. J. Van Depoele, 429,746. *Telpher System*, C. J. Van Depoele, 429,747 *Railway Signal System*, L. B. Firman, 429,899. *Electric Railway Conductor System*, C. J. Van Depoele, 429,981. *Wire and Track Cleaner*, J. Bauer, 429,990. *Electric Railway*, R. M. Hunter, 430,025 and 430,076. *Electric Railway Reissues*, W. H. Knight, 11,083 and 11,084.

Secondary Batteries:—*Secondary Battery*, C. Hering, 429,912, 429,913 and 429,914.

Telegraphs:—*Multiplex Telegraphy*, F. J. Patten, 429,735.

Telephones and Apparatus:—*Telephone*, W. Vogel, 429,801.

THE SYSTEM OF THE INTERIOR CONDUIT AND INSULATION COMPANY.

FEW innovations in the electrical field have excited so much interest of late years as the methods and appliances of the Interior Conduit and Insulation Company of this city, as embodied in their system of wiring houses, office buildings, &c. The company have now issued their prospectus, which is not only a publication of considerable literary merit but enters very freely and exhaustively into a discussion of the vital questions involved in insulation.

After a brief review of the development of electrical distribution and of the dangers involved in fire, the pamphlet points out that if all such actions as tend to cause a fire were made instantaneous and were localized, whatever prejudice still remains against electricity would disappear. It then says:—

"Prior to the inauguration of what may be termed the new electric era, electricity was used almost solely for the purpose of transmitting intelligence; the telegraph, the telephone, the fire-alarm, the various signalling systems and kindred applications are examples of such use. In these industries the insulation of the wires has but one function, viz.: That of maintaining an effective service. If the insulation fails, the service fails; no other untoward result follows for the reason that the currents employed are so weak as to be incapable of developing any considerable degree of heat. With the inauguration of the new era involving new applications, as for example, electric lighting, electric motive power, and kindred uses, employing electricity under high pressure and in vast quantity, there was imposed upon insulation an additional duty, viz.: that of protecting life and property. If herein the insulation fails, not only does the service fail, but life and property are at once seriously jeopardized. That this risk is not an imaginary one is abundantly attested by the numerous recorded accidents which have occurred during the past two or three years. That the remedy for these occurrences is not to be found in an improvement in the quality of insulation is equally well attested by the fact that, in spite of all the manifold so-called "perfected insulations," accidents continue to occur. As a matter of fact, the one branch of electrical science which has not advanced in line with the new demands is this safe-guarding of property from contact with the always-possible abnormal heat development in the wires." It has been assumed by some that inasmuch as electricity was inherently safer than other mediums of lighting, the element of danger was practically absent, and by others that the danger could be sufficiently avoided by improvement in the quality of the insulation, hence the evolution of a host of "improved insulations;" many of which doubtless possess great virtue, but unfortunately they all follow one principle, viz: That of affixing the insulation to, or drawing it upon the wire itself. This is the fatal error. The logic of all the relating facts in the art is against such practice. Modern electrical service is nothing more or less than a service for the distribution of heat. True, economical considerations demand, and physical laws permit, that the conductors conveying this heat shall be so arranged and so proportioned as to remain cool, and therefore safe while doing the calculated duty demanded of them. But the proportions and conditions thus pre-arranged and determined to secure safety are peculiarly liable to accidental derangement, thereby imposing a duty for which they were not calculated; in this event the conditions of safety are gone, and heat is at once developed in such proportion and in such place as the extent and the nature of the derangement may determine. It is apparent, therefore, that any system of insulation which aims to secure absolute protection must take cognizance of, and provide against, the effect of this always possible development of heat. Experience has demonstrated that the practice of affixing the insulation to the wires does not do this. All insulations which can be so affixed are of necessity compounded of oils, gums, or other flexible and adhesive materials, all of which are readily affected by heat. Vain efforts have been made to find a new elementary material, or to compound known materials which shall have the multifold property of high insulation, great resistance to heat, extreme flexibility and proof against acids, gas, etc. The great value to the art of an insulation possessing these naturally diverse qualities has been of late years so keenly appreciated as to concentrate the inventive mind on the line of its pursuit to the exclusion of any consideration of other methods of protecting the wires. This is the only explanation of the failure of the inventors to evolve a natural and effective solution of the problem. Necessity has been well said to be "The Mother of Invention," and it was by virtue of the necessities of himself and the numerous friends who depended upon him for advice in such matters that Mr. Edward H. Johnson was led to suggest the total abandonment of the old practice, and the substitution therefor of an enclosing tube, separate from, but forming a channel for conducting wires, continuous throughout their every ramification, thus fully protecting every inch of wire and rendering it accessible for periodic inspection or renewal, and by the same means absolutely confining within the safe limits of a non-inflammable channel the possible heat development.

"The practical efficiency of such a method scarcely needs to be supported by argument or demonstration. Its very simplicity appeals at once and alike to the intelligence of the expert and the layman.

"The elimination of the element of extreme flexibility as an essential requisite of insulation simplifies the problem, and permits of the employment of a variety of materials not at all available in the practice of affixing the insulation to the wires. Thus the door is opened and the inventor now comes forward to provide the requisite perfection of detail. In this respect the industry is extremely fortunate in the chance which has brought to its aid Mr. Edwin T. Greenfield, a man of wider experience in the old method, and therefore more keenly appreciative of its weakness, than any man in this or any other country; to the thoroughness with which Mr. Greenfield has and is doing his work is due the already high perfection of the new method and the guarantee that it will at once afford superlatively the elements of safety, economy, durability and convenience.

"In further pursuance of the conditions of safety, Mr. Johnson has incorporated with the new system a special conductor upon which he has been at work for some years, the function of which is to convert conditions favorable to a prolonged heat presence into conditions of instantaneous action hereinbefore described as a factor of safety. This conductor is so constructed as to convert all defects which may develop in the wires, such, for illustration, as a break, a leak, an imperfect union or other faults common to all systems of energy distribution into that one defect or fault which is pecular to electrical distribution and which is technically known as a "short circuit." This is a fault which develops instantaneously an abnormal concentration of energy and in consequence effects the immediate destruction of the weakest link in the chain which supports the current. Much has been said and written of the device known as the "safety fuse" and rules and regulations enforcing its use are universal. It is introduced as a link in every electrical chain and is designedly made the weakest link therein—hence a "short circuit" simply means the destruction or giving way of this link, thus insuring by the breaking of the chain the total and absolute cessation of the electric current previously supported thereby. This weak link is, of course, located within safe pockets where the somewhat violent results of its disruption are smothered or otherwise rendered abortive.

"Contrary, however, to popular belief this device does not provide absolute protection. Its failure to do so arises from the fact that it is only affected by an overloading of the chain. It is, of course, apparent that a partial break, an imperfect union or a leakage of the current may develop a sufficient degree of heat to effect the ignition of inflammable materials, and yet not sufficiently increase the current strength to overload and fuse the safety link.

"The object of the special conductor herein alluded to is to convert with absolute certainty all defects, whether a break, a leak or other fault into a "short circuit" and the consequent overloading and fusing of the safety link. The effect of a "short circuit" is generally apparent at the point of its occurrence in the form of an instantaneous flash, herein before alluded to as ineffective of much damage becauseof its brief duration. It is possible, however, to have present conditions of extreme inflammability, as for instance gases, inflammable powder, as in a flour mill, lace or other delicate fabrics, or even the insulation of the wires themselves.

"It therefore becomes a matter of considerable importance to safely localize even this flash, and it is obvious that the inclosing tube does this to perfection, in that every inch of the wire is completely encased within the safe confines of its fireproof interior.

"The Interior Conduit and Insulation Company now enters the field with this new method of insulation, and claims that it is able to effect, not partially and imperfectly, but completely and absolutely that safety which is the one essential to the general adoption of electricity. That this claim is not unsupported is attested by the endorsement the system has already received by architects, electricians, fire underwriters, municipal and other authorities interested in the matter of safeguarding property, and the extraordinary rapidity with which it has been accepted by the public."

The pamphlet then takes up the subject of underground work, and deals with the adaptability of the company's safety tubes for underground conduits. We understand that large contracts for this important class of work are now being carried out, one in Detroit by Mr. C. J. Field, for electric lighting, and another in a Western city for the distribution of electric railway feeders. The following passage is of unusual interest;—

"It is confidently believed that the insulation of the tube itself, combined with the means employed to prevent access of moisture and gases, will sufficiently protect the conductors to enable the customary insulation employed on underground cables to be entirely dispensed with. This belief is so strong that large installations are now being made in which the wires are entirely devoid of insulation, other than that afforded by the tube itself. Whether this practice will be found generally satisfactory or not, it is certain that a comparatively light insulation will suffice, and that the costly and cumbersome insulations and lead sheathing heretofore employed will henceforth be wholly unnecessary. The great evil of condensation, so destructive of all wire insulations, and which is at its maximum in metal conduits, is scarcely a factor in these insulating tubes. It is certainly reduced to a minimum, and is thus within the easy reach of the corrective means which are employed in conjunction with the system. The provision for protecting the conduits from moisture and gases, also prevents the accumulation of gases in the manholes, and consequently avoids the dangers of explosion which attend other systems. The absence of metal sheathing of any kind is an important advantage, as in all systems of electrical distribution which are partly aerial and partly underground, lightning is apt to reach the underground from the aerial wires, and is almost certain to pierce the insulation to get at the metal sheathing, for which it has a great affinity.

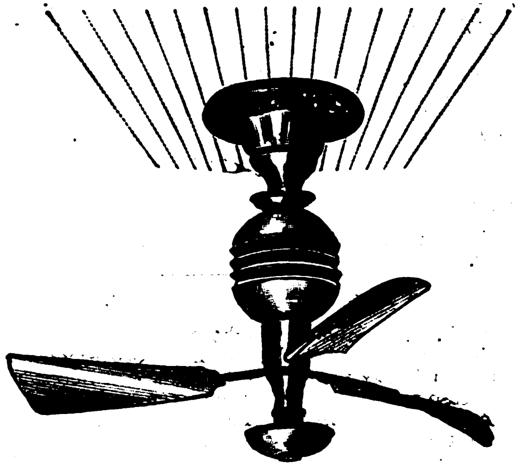
"As the length of cable sections which may be drawn into the ducts, and the consequent frequency of manholes in any conduit is determined by the weight and size of the cables to be drawn in, it becomes a matter of considerable importance to eliminate from the cable all material other than the copper itself, thereby permitting less frequent manholes with a conductor of a given capacity, or the use of conductors of greater capacity with a like number of manholes than is possible with cables employing thick insulations and heavy metallic sheathing.

"Furthermore, if a cable consists only of copper, its withdrawal and substitution by a larger one, does not result in its consignment to "scrap" as in the case of insulated cables. It is in fact just as valuable then as it was originally and may be at once employed in lighter service elswhere; a fact which materially heightens the economic value of the insulated conduits.

"A feature of considerable value is the facility with which a conduit may be given individual ducts of various sizes thus offering greater accommodations for single conductors and small cables than is possible to conduits in which ducts of uniform sizes only are employed."

A FAN, MOTOR AND BATTERY OUTFIT.

The Central Electric Company, of Chicago, are exhibiting a very handsome ventilating fan, the product of the Globe Fan Co., of New York. The fan is entirely of metal, nicely nickeled, light and ornamental in design, and is especially adapted for use in restaurants, saloons, offices and stores. The fan is run in connection with a small motor, and the Edison-Lalande battery and the combination seems to exactly fill a demand that has long existed. The motor can of course be run by the current from an electric light circuit where this is obtainable, but for sick room or residence purposes the battery furnishes the necessary power. The cut herewith illustrates the fan itself. The Central Electric Company has secured the general western agency for this fan and already reports several sales.



THE GLOBE ELECTRIC FAN.

A TELEGRAPH TOURNAMENT IN ST. LOUIS.

Our St. Louis correspondent writes us as follows :—The fast sending tournament of the St. Louis telegraphers, took place last Sunday at Entertainment Hall of the Exposition Building. Each contestant was allowed five minutes, the start being made by a bell signal, and at the end of five minutes the circuit was thrown open by the master clock of the Western Union time service. The prizes were awarded as follows :—

First Class, highest readable speed, first prize $50, to J. M. McAndrews, Postal Telegraph Co., 226 words; second prize $30, to A. O. Ellis, Postal Co., 224 words; third prize $20, to J. C. McIlvane, Western Union, 221 words.

Second Class, highest speed combined with the most perfect Morse; first prize $25, to A. O. Ellis, Postal Co., 224 words; second prize $15, to T. M. Eckert, Western Union, 212 words; third prize $10, F. C. Richie, Associated Press, 210 words.

Third Class, highest readable speed. ladies exclusively, first prize $25, to Miss. Mollie Landrigan, Postal, 206 words; second prize $15, Miss Katie Higgins, Western Union, 202 words; third prize $10, Mrs. Flora A. Potter, Western Union, 191 words.

Fourth Class, old-timers, service prior to 1865, highest readable speed, first prize $25, C. E. Turner 199 words; second prize $15, Mark D. Crane, Western Union, 197 words; third prize $10, James W. Cook, Postal, 179 words.

THE ELECTRIC LIGHT IN THE SUEZ CANAL.

In his last report to the Foreign Office, the British Consul at Port Said gives the following interesting figures with regard to the application of the electric light to vessels navigating the Suez Canal at night. In 1887, 395 steamers used the light; in 1888, the number rose to 1,611, and in 1889, a total of 2,445 vessels navigated the canal with its aid. The average time of transit has been reduced to 22½ hours. The shortest time taken by a steamer in passing through the canal in 1889 with the aid of the light was 14¾ hours.

A NEW METHOD OF COVERING PULLEYS.

In driving all classes of machinery by means of belts, a certain loss of power is always entailed by the slipping of the belt upon the surface of the pulley. This loss becomes a very important consideration in the majority of cases, especially in machinery running at a high speed, and any means of diminishing it in a marked degree is to be hailed by engineer and capitalist as an improvement of marked interest, the merits of which should be immediately looked into, and, if found satisfactory, at once utilized. The latest method of overcoming these losses, and one which appears to present some peculiar and prominent advantages, is now being introduced by the Eureka Cement Company, of Owosso, Mich. Mr. Frank Henderson, of that company, is very busy installing their system in all parts of the country, and introducing it to the notice of those interested in such matters. This system comprises the following points: It consists in the employment of a specially prepared leather covering for the pulley, which is extremely soft and elastic and never glazes by the rubbing action of the belt, as is the case when ordinary leather is employed for this purpose. It is applied to the pulley and held firmly to it for all time by means of a special cement, which is soft and never hardens like ordinary felt cement or glue. No rivets of any kind are employed, but the leather covering is firmly attached to the iron of the pulley by the cement alone. In carrying this out the iron pulley is first subjected to a secret treatment by which means this very desirable result is attained. Heretofore it has been found impossible to effect any lasting contact between leather and iron, the covering invariably working loose from the pulley unless mechanical means, such as rivets, with their accompanying disadvantages and troubles, were employed. By this system it is claimed that 50 per cent. more power can be transmitted, and all slipping is reduced to an imperceptible factor, producing a perfectly even motion, especially desirable in the case of dynamo electric machines. Belts may be run much looser, thereby reducing loss by friction in journals and the liability of hot boxes to a minimum, and causing the machine to run very much more easily. The leather covering is put on so that it is as even and true as though turned in a lathe, and it is estimated that one man can cover at least 50 square feet per day. Once attached, the covering will stand for years, and never loosen or come off except when naturally worn out, the length of time varying with the circumstance and work done. Some pulleys have been covered and the slip absolutely stopped when it amounted to as much as 15 per cent. In other places, where the oil on the belt was so great that the machine had to be laid aside, as it was found impossible to drive it running on an iron pulley, a perfect alleviation of the trouble has been effected. This system is already in operation in some of the finest electrical plants in the country, among which may be mentioned the plant in the Auditorium, Chicago, and the Edison and Brush Companies' stations in Detroit, and is also being used in many other industries. The improvements effected by its use are of such a palpable nature, and the remedy for troubles heretofore existing is so simple, that the matter is one which will be looked into and rapidly adopted by those engaged in the transmission of power by means of belts in the operation of machinery of all kinds.

EDISON'S ELECTRO-MAGNETIC ORE SEPARATION.

Reports from Middletown, N. J., state that the Edison Contracting Company has equipped fine works for operating at the Ogden iron mines, has built houses for its workmen, and laid a spur road from the Susquehanna and Western railroad to the mines. It is said that Mr. S. O. Edison will have charge.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

KERITE WIRES AND CABLES.

Mr. Geo. B. Prescott, Jr., the general agent for Day's Kerite wires and cables, 16 Dey street, has just issued a very tasteful, comprehensive and interesting " Price List," of 40 pages. The introduction in calling attention to the fact that Kerite has been in the market for nearly thirty years, says:—" It is proof against the corrosive elements in earth, air or water; the greatest extremes of heat and cold do not impair its flexibility, firmness or insulating properties. It will endure long-continued heat at 200° F., and, for short intervals, 250° to 300°, and may be safely immersed in boiling water. Acids act upon it very slowly, strong solutions of alkalies do not injure it, and it is less affected by chemical re-agents than any other insulating covering. Gutta-percha in the open air soon becomes brittle, cracks and falls off; with exposure to the sun it softens, then cools, shrinks, cracks, dries and falls off, thus destroying insulation. India rubber, even when vulcanized, only partially escapes these difficulties, while Kerite is subject to none of these objections, and does not, like the preparations of gutta-percha, or vulcanized rubber, contain the elements of its own destruction. Mineral oils, illuminating gas, or the roots of plants do not affect it, and the action of water, salt or fresh, protects it and improves its insulation. The marine borers of southern and tropical seas, which destroy gutta-percha, do not attack it; it is proof against the heat of the tropics, which renders all other insulations useless, and against the ravages of white ants, which destroy gutta-percha. The qualities that render it indestructible by solar heat, or corrosive agents, insure its durability in all climates, and while neither gutta-percha nor vulcanized rubber will bear long storage without great and rapid deterioration, Kerite, under the same conditions, undergoes no change."

A large number of tables are given for all classes of telegraph, telephone and electric light wires and cables, and we notice on page 22 a new table of value for iron wire. Cuts are also given of the various makes.

The concern is reported by Mr. Prescott to be as busy as usual, the factory running to its full capacity on wires, cables, tape, etc. One cable finished a few days ago for the Western Union Co., is half a mile long, and is intended to be laid out West. It is a 5 conductor, each consisting of 3 strands of No. 18, B. W. G., insulated to $\frac{9}{32}$ in. The double armor consists of 30 No. 12 galvanized steel wires, and 14 No. 4 galvanized steel wire outside of that.

THE INTERIOR CONDUIT AND INSULATION COMPANY.

This company, of 16 and 18 Broad street, signalizes its occupation of its handsome new offices on the second floor by issuing in compact and severely elegant form its prospectus, to which extended reference is made in another part of this issue. The officers of the company are E. H. Johnson, President; S. Bergmann, Vice-President; W. A. Willard, Secretary and Treasurer; J. H. McClement, Comptroller; E. T. Greenfield, Electrician. Messrs. Johnson, Bergmann, McClement and Greenfield are directors, with P. H. Klein, H. Steers, C. E. Runk, S. Insull and F. J. Sprague. The entire system and details have been and are being protected by letters patent, which, it is claimed, secure to the company practical immunity from competition. It is not intended, however, to exploit the business in reliance upon patents, but to establish it upon a sound commercial basis, recognizing the force and value of competition precisely as if the patents did not exist. It is the intention of the company to supply the trade at large upon equal terms and solely upon a manufacturing basis, not handicapping the business with royalty charges or excessive profits. The demand is large, and it is intended to supply it at a price which, while netting the stockholders fair profits, will insure satisfaction to its customers and minimize the incentive to infringe the company's patents. To accommodate the rapid growth already achieved, new and enlarged factory facilities have been provided, and the company thereby becomes equipped to promptly and satisfactorily supply the future, as well as the already considerable demand.

JOHNSTON ELECTRIC TRAIN SIGNAL CO.

The Johnston Electric Train Signal Co., of Boston, have purchased a valuable property at Woburn, Mass., which they will occupy and utilize immediately as a factory. The building is four stories in height, has a frontage of about 100 feet, and is upward of 200 feet long. It is located near the railroad, and its facilities are excellent. The Company will set up its machinery at once, and within a month will probably have at least 100 mechanics at work. It is the intention of the Company not only to manufacture the train signal, which is meeting with general approval, but push-buttons of all descriptions, and a number of new specialties in the electric hardware line.

THE TRIUMPH COMPOUND ENGINE.

This new type of engine, which is now becoming well known and highly thought of for its smooth running qualities, its simplicity and the exceedingly small floor space it occupies, would, by this time, have been installed in one of Cincinnati's largest central stations were it not for the molders' strike which is embarrassing so many manufacturers in that vicinity. However, the company expects to be under full swing in the course of a few days, and in the meantime electric light and power men have a splendid opportunity of seeing the sixty horse-power engine running in the works of the company and viewing the construction of a 250 horse-power engine now being built for electric lighting and power purposes.

THE SEBASTIAN-MAY CO.

The works of this company in Cincinnati are not only of interest on account of their completeness and facility of turning out machinery, lathes, etc., promptly, but also because here we find one of the largest, if not the largest, electric motors in Cincinnati. Mr. Sebastian recently told one of the staff of THE ELECTRICAL ENGINEER, who had the pleasure of visiting his works, that heretofore his company had been compelled to content themselves with power furnished through shafting from an adjacent building—a power which was not only inadequate but unreliable. The different electrical people, he said, finally convinced him that a motor was what he wanted and now a twenty horse Queen City electric motor (440 volts) is running the entire factory noiselessly, easily and satisfactorily.

CARD MOTOR AND DYNAMO CO.

Since the reorganization of this company under the able management of Mr. Walter, the facilities of their Cincinnati factory have by no means been adequate to meet the demand for their various sized arc and incandescent motors. It will doubtless be only a short time ere the natural expansion of this company will be able to take care of orders as fast as received.

THE STILWELL AND BIERCE MFG. CO.

This company which is so well known through the large number of Victor turbine wheels it supplies to electric lighting and power plants from year to year where water power is available, is now turning out an unusually large order for the electric light company at Spokane Falls. There will be no fewer than thirteen of its large horizontal turbines side by side in this installation, all running on the same line of shafting. One of the features of this outfit is the very ingenious and effective system of clutches by which the different wheels are thrown in and out. Electric light and power people will look with interest at the final results which will be shown in this remarkable instance of the effective utilization of water power in connection with central station work.

NEW WESTINGHOUSE WORK.

The Newark, N. J., Electric Light and Power Company has been compelled to make some important improvements and enlargements in its incandescent plant. This was necessitated by the great increase in the demand for the light made upon the company by its many customers. The corporation has been very successful in the establishment of the electric light plant, which has been on a paying basis from the very day it was organized. A good deal of this success is attributed due to the fact that the company adopted the Westinghouse alternating current system of electric lighting. Apparatus of a capacity of 2,250 sixteen candle-power lamps was installed in the plant at first, and the last increase made the total capacity of Westinghouse alternating current machinery 3,750 lights.

Another town in the Lone Star State has pushed down the breast-works of barbarism and joined the procession in the progress of modern improvements by introducing the electric light within its precincts. This time it is Cleburne, Texas, whose enterprising citizens have formed an electric light company and also made a contract with the Westinghouse Electric Company for one of its 500 light alternating current machines.

THE LAW TELEPHONE COMPANY.

Mr. W. A. Childs, of the above company, 85 John street, reports business as active in all the various departments. The new Law board, building for Philadelphia, is to be about 100 feet long; it will actually bring 10,000 connections within the easy reach of each operator, sitting down. It will, Mr. Childs says with pride, be the most striking exemplification to be found in the telephone field of concentrated capacity and ease of manipulation. The Law battery continues in as great demand as ever, and with it go a great many specialties in the supply line. The company has made a great success lately of its special tables and sets for medical use.

WESTINGHOUSE MACHINE WORKS.

Few persons are aware of the magnitude of this concern and the immense number of engines they are constantly turning out. Their works in Pittsburgh cover two whole squares and still they are cramped and pushed for room. Between 180 and 240 separate engines are all the year round in process of construction, not counting the finished ones in the warehouse ready for shipment, which would bring the number up to 400. Every department is systematized and complete in in itself. All their molding is done by themselves in their own foundry. Their bouchings, eccentric brasses, and all their anti-friction metal is made from their own mixtures, differing with the particular use to which it is to be put. They make their own forgings—from the smallest to the largest—under their own hammers, and, finally, after the engine passes to its completion, it is not only tested thoroughly, but all the data of tests are kept and filed, signed and vouched for by the very names of the particular men in the shop by whom the tests are made. If, after the engine has been sold, the purchaser complains that its performance is not satisfactory, that his indicator cards show certain irregularities of valve setting, etc., these faulty cards are sent for and compared with the test ones on file, and experience usually develops the fact that the complainant's engine is less to blame than the manner in which the card is taken or the indicator set.

There now 508 men employed at the Westinghouse machine works, and when their building additions and improvements are effected even this large number will be increased.

One would naturally imagine that the working head of this vast establishment would be a very busy man. He doubtless is, but Manager Bagaley would impress the casual visitor as the most unconcerned and disinterested man at the works. Great is system!

The Westinghouse Machine Company, of Pittsburgh, sold during May 79 compound engines, with an aggregate horse-power of 5,005. A number of these went to France and Germany, and one 75 h. p. Standard went to Brazil. Two 250 h. p. engines were sold to the Detroit Electric Light and Power Company, and a similar one to the Excelsior Electric Company, of Port Huron, Mich.

THE ELECTRIC MERCHANDISE CO.

Mr. W. R. Mason, the general manager of the Electric Merchandise Co., 11 Adams street, Chicago, has issued the following notice to their friends and patrons: "We have purchased the merchandise business of the Sprague Electric Equipment Co., and shall carry on the same at the above address. We shall continue to manufacture appliances of all kinds for use by electric railways, irrespective of system used, and shall carry a large assortment and complete stock of all devices used by the respective systems, in station, car or line work. We have in process of manufacture many improvements in car fittings, line material, etc. It will be our earnest endeavor to have the very best material in the market at the lowest price and guarantee promptness in delivery. Our catalogue and discount sheet will be mailed on application. Hoping to merit your patronage and soliciting correspondence in relation to electric railroad building, extensions, supplies, etc., we are," &c.

EUREKA TEMPERED COPPER.

The Electro-Dynamic Co. of Philadelphia, in a recent letter to the Eureka Tempered Copper Co., of North East, Pa., say: "It is with much pleasure that we are able to state that we have used about one thousand pieces of your tempered copper with entire satisfaction. We have found the metal to be of uniform hardness and entirely free from flaws or blow-holes. As cast copper we regard it as a superior article."

THE McINTIRE SPECIALTIES.

C. McIntire & Co., 13 and 15 Franklin street, Newark, N. J., are pushing their well-known electric wire connectors and terminals in the electric light and power field as well as among the telegraph and telephone people. Their more recent productions include lamp and cut-out terminals, which are turned out for all makes and sizes of lamps. They also make patent lightning arresters, in use by the Metropolitan Telephone Company, of this city.

STANDARD UNDERGROUND CABLE COMPANY.

The new factories now being built by the Standard Underground Cable Company at Brinton, Pa., are to be completed and in operation early next November. The enormous increase in the business of this company has made necessary a corresponding increase in the manufacturing facilities. Mr. J. W. Marsh, the secretary, has just been formally elected assistant general manager, retaining also the title and duties of secretary. All who know Mr. Marsh will admit that this recognition of his services and ability is well deserved, and will hasten to congratulate him.

THE SCHISEOPHONE.

This instrument, which is due to Captain du Place, is, like the "electric acoumeter" described in THE ELECTRICAL ENGINEER recently, merely a modification of Prof. Hughes' sonometer. The object of the schiseophone is to facilitate the detection of flaws in metal bars, etc.; and according to our French contemporaries, some recent trials of this apparatus at the Ermont workshops of the Northern Railway of France have proved it to be practically useful. The instrument comprises a striker and an audiometer. A steel rod is moved to and fro in front of a microphone, periodically striking the metal bar under examination. Two coils, one movable and connected to the microphone, the other fixed and connected to two telephones, are arranged on a graduated rod. Having placed the movable coil so that the telephones are silent so long as the hammer is striking a solid portion of the metal, the hammer is moved along the bar, and should there exist a flaw in it, the increased noise given out causes more powerful currents to flow in the microphone circuit, with the result that the telephones are no longer silent.

C. J. KINTNER.

Mr. C. J. Kintner, the well known expert and patent solicitor, has been made the expert of the Aldrich Court plant, this city. Mr. Aldrich has set apart a room for him for laboratory purposes. He will be supplied there with direct and alternating current for expert purposes, and will shortly be ready to make all classes of tests.

NEW YORK ELECTRICAL MANUFACTURING COMPANY.

A few months ago Mr. Augustus Noll, one of the pioneers in the electric wiring and installation business, organized the above company, and believing in the future of the motor industry secured control of the Barriett motor. He opened offices in the Western Union building, corner of Fifth avenue and West Twenty-third street, and also started a factory in this city. Since that time, he has devoted his energies and a considerable sum of money, to the improvement of the Barriett motor and the construction of new sizes, the factory being under the personal direction of Mr. Barriett who, it may be said, is an electrical engineer without a superior in the details of mechanical work. The new Barriett motors embody a number of new features of merit, and Mr. Noll deserves the highest praise for his insistence on thoroughness and excellence of workmanship in every motor that leaves his shops, which by the way, are fitted up with all the latest and best machinery as well as a large number of special tools invented by Mr. Barriett himself.

It should be mentioned also that Mr. Noll's long experience as a construction engineer causes his services and opinion to be in constant demand for various classes of work, and hence the factory of the company is not less busy on special orders entrusted to him for execution. Altogether the New York Electrical Manufacturing Company will have a summer full of occupation and yielding its fair proportion of profit.

THE BAXTER ELECTRIC MOTOR COMPANY.

The New York *World* of June 15 contains an illustrated article on the Baxter motor and works. It is stated that there are now over 4,000 Baxter motors in use, and the company are preparing to make larger sizes as well as to undertake work in several new departments. Special attention is called to the arc motors, the success of the company having largely been achieved in this special field, in which it was a pioneer. Since its re-organization the company has met with a most encouraging reception for its product.

The article referred to says: "The Baxter Company have plans worked out for electric generators of large sizes up to 500 and 1,000 horse-power, and will soon have such machines on the market.

"They are also getting ready to place upon the market electric pumps, which will be a combination of an electric motor and a pump; just so much so as a steam-pump is a combination of a steam-engine and a pump. This will be a great improvement in this line. At present a large number of motors are used to run pumps for elevator purposes, but as there are no electric pumps the arrangement now employed is to use an ordinary power pump, which is run by a belt from a counter-shaft, this counter-shaft being driven by an electric motor. This is a clumsy arrangement and takes up a good deal of unnecessary room.

"They are engaged likewise in making experiments on a new electric railway system which they believe will be a complete solution of rapid transit in cities. The system they are working on is one in which the power to run the cars will be applied directly to the car-axle, thus dispensing with all the complicated gearing and mechanism now used to connect the motors with the car-wheels."

WESTERN TRADE NOTES.

Mr. John H. Finney, of the Cincinnati office of the Westinghouse Electric Co., was in town this week on important business for the company.

Mr. J. C. Liggett, who had charge of all the wiring and construction work of the Westinghouse station in Evanston, Ill., has been appointed superintendent of construction of the new Edison 20,000 incandescent light station which is being put in at Milwaukee.

Mr. Frank Henderson, Gen. Supt. of the Eureka Cement Co., of Owosso, Mich., is in town installing and introducing their new system of covering pulleys, which has numerous important advantages over the ordinary methods, and by means of which all belt-slipping is entirely eliminated.

The Central Electric Co., 116–118 Franklin street, Chicago, report the demand for their famous okonite wire as being very great and extending all the time. They are doing a big business in electric light and railway supplies, particularly among their specialties. They have recently been appointed Western agents for the Globe Fan Company, of New York, and are rapidly introducing these very desirable fans, which can be operated either by an electric motor and primary battery or any other suitable power.

Mr. Morris, of the Novelty Electric Supply Company of Cincinnati, is in town, where he will remain for about a week. He is spending his time calling on his various customers and friends, showing them his most recent specialties in line, electric light and power and electric railway supplies. He has some remarkably good things in this line ready for the market, and numerous others which will be introduced in the very near future. The company are doing a large business and enjoy an enviable reputation for the excellence and durability of their goods, which are in large demand everywhere.

Mr. Myron A. Knapp, of the Knapp Electrical Works, has been very actively engaged for the last few days in fixing up his building—kalsomining, papering, painting, etc., those portions which were injured by the recent fire on his premises. Notwithstanding this occurrence, with its many drawbacks, his large orders were all promptly shipped, and the business conducted as expeditiously as if nothing of the kind had happened. Grimshaw White Core wire, Perkins lamps and Mayo motors are selling all the time, and the prospects of the company for the future are exceeding bright and hopeful.

Mr. M. E. Baird, of the Eddy Electric Motor Company, of Windsor, Conn., is in town for a few days looking after some of the Eddy interests in this section of the country. He reports the business of the company as in splendid shape and continually increasing. The general merits and fine mechanical and electrical workmanship of these machines is finding for them a ready sale, and purchasers are unanimous in their expressions of the thoroughly successful way in which they do their work. The company is ably represented in the West by Mr. G. A. Edward Kohler, who has fine offices at room 329 The Rookery, where he is at all times glad to explain the operation and mysteries of his motor to the uninitiated.

Mr. Forée Bain has just returned from a trip to the coal mining regions of Iowa, where he has been carefully looking over some of the mines located there, with the view of fitting out two of the largest with a complete equipment of electric machinery, comprising motors for transmission of power, dynamos and electric lighting apparatus. Mr. Bain is remarkably busy building his new motor-dynamos, which were illustrated and described very fully in a recent issue. These machines are giving very excellent satisfaction among their users. One recent order alone amounted to seven 15 horse power motors. This machine is of very solid mechanical construction, simple and not liable to get out of order, and its electrical conditions have been most thoroughly and carefully worked out, thereby obtaining very high efficiency in operation.

The Munson Belting Company are very busy putting in their new machinery, to accommodate which they have largely increased their floor space. Their business is on the increase all the time and orders come pouring in from all sides. Col. Shay the "electrician" of Munson Belting fame, so well known in central stations all through the country, has just returned from a trip to St. Louis, where he captured a fine order for 266 feet of 54-inch and 300 feet of 16-inch belt. Your representative had the pleasure of being shown over the factory by Mr. Morgan, who took the greatest pains in explaining the ways and methods of manufacturing belting of the finest quality and the modus operandi of the various labor-saving and perfecting machinery. None but the very best quality of leather is used in the manufacture of this belting and infinite trouble is taken in the various processes to produce the finest possible product, in which, if we may judge from their large business and the high esteem in which this belting is held, the Munson Company are eminently successful.

NEW ENGLAND TRADE NOTES.

Messrs. Bird and Sloane, have formed a company for the purpose of doing all kinds of wiring for various electric purposes. Mr. Bird was formerly with the Edison Electric Company, and Mr. George H. Sloane is the well known inventor of the "Advance" primary battery. Their headquarters are at 44 Sudbury street, Boston.

The Thomson Electric Welding Company has just made a contract with the Roebling Manufacturing Company of Trenton, N. J., to supply seven additional welding machines. They have also made contracts with the U. S. Government to install the welding plants at the New York and Norkfolk Navy Yards, and with the Pennsylvania Railroad for a large plant at the Company's works in West Philadelphia.

The Providence Construction Company, of Providence, R. I., of which Mr. E. W. Fyler is manager, are making a specialty of enameled wood electric light specialties, which are in great demand. They make adjusting balls, rosettes, lamp socket bushings, adjusting "peanuts," etc., in various colors, which are cheaper than rubber or other material, and yet present a highly finished and artistic appearance for a very moderate price.

The Smith Electric Company, of Attleboro, Mass., are now doing a large manufacturing business of electric bells, gas lighting keys, nickel press buttons, switches, door pushes, spark coils, incandescent rosettes and batteries of all kinds. Mr. Smith manages the business personally, and has by continued and persevering application built it up in the past year to quite a successful issue. The goods are all first-class, and he has special facilities for the economical and correct production for all kinds of electric work.

The Municipal Signal Company, 79 Franklin street, Boston, has lately been awarded the contract for the equipment of three police precincts in San Francisco with their well-known "Police Alarm and Inter-Communication System." Capt. Rosell, of the U. S. A. Engineers, who lately visited Boston and other cities under orders to investigate the merits of existing systems of police alarm in order to determine what system should be used in Washington, D. C., has made a report in favor of the Municipal System, and the District Commissioners have unanimously awarded the contract for the equipment of the Georgetown police precinct to the Municipal Signal Company.

The Standard Electric Time Company, of New Haven, Conn., have begun to extend their business into Canada, and are busy working up this new field. They have recently placed a plant consisting of one regulator and eight clocks in the mills of The Rosamond Woolen Company, at Almonte, Ont., which is giving entire satisfaction. Probably the finest plant which they have ever installed, is the one which they recently sold to the new Bank of Commerce building in Toronto, which is one of the finest buildings in Canada, the inside being extremely handsomely decorated. The plant consists of one regulator and seven clocks, and the whole of the fittings had to conform to the interior decoration of the building, the dials being specially highly finished. The dial in the main banking hall is three feet in diameter, black with gilt hands and figures, and is contained in a handsome hand carved cherry wood case six feet high.

Mr. Philip Bell Downing, of Boston, has recently invented and patented a mechanical device for operating street railway switches, which are peculiarly adaptable for electric railways. The parts are all strong and direct-acting, and the switch is not at all liable to get out of order. This mechanism is operated in two ways—one by the wheels of the car and the other by an independent wheel or axled sphere in control of and operated by the driver, by means of a brake handle. When a car has switched off, and the one following it is to continue on the main track, the switch is thrown back automatically by the wheels of the car; but when it is desired to go off from the line and follow the car switching off, then the driver turns the brake handle and the sphere-wheel is brought down to the surface, strikes the projecting stud of the switch mechanism, the switch is turned, and the car goes on to the branch line without interruption or failure of any kind—the wheel of the car following striking another stud as it comes along and setting back the switch so that the line is continuous. The switch is well adapted for horse, electric and elevated roads. Its strength, simplicity, quick and positive action all render it a most complete device for the purpose for which it is intended, and all the leading street railway and electric railway men who have seen it pronounce it to be entirely satisfactory.

NEW YORK TRADE NOTES.

Mr. Y. J. Symmes, president of the well-known gasfixture house of Thomas Day & Co., limited, of San Francisco, was in New York last week on electrical business.

ST. LOUIS TRADE NOTES.

Mr. B. J. Arnold, engineer and agent for the Thomson-Houston Electric Co., has removed his office to room No. 115 Chamber of Commerce building.

THE
ELECTRICAL ENGINEER.
[INCORPORATED.]
PUBLISHED EVERY WEDNESDAY AT
150 Broadway, New York City.

GEO. M. PHELPS, President. F. R. COLVIN, Treas. and Business Manager

Edited by
T. COMMERFORD MARTIN AND JOSEPH WETZLER.

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Western Manager, W. F. COLLINS, Temple Court, 225 Dearborn Street, Chicago, Ill.

TERMS OF SUBSCRIPTION, POSTAGE PRE-PAID.

United States and Canada,	per annum,	$3.00
Four or more Copies, in Clubs (each)	"	2.50
Great Britain and other Foreign Countries within the Postal Union	"	4.00
Single Copies,		.10

[*Entered as second class matter at the New York, N. Y., Post Office, April* 9, 1888.]

EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers*

VOL. IX. NEW YORK, JUNE 25, 1890. No. 112

> ***The general public have but a limited understanding of the great growth already attained by the industries devoted to the practical application of electricity and the enormous development of which they are capable.—Henry Villard.***

UTILISING WATER POWER ELECTRICALLY.

THE extent to which water power is utilized in the manufactures of the country has not arrested attention as it deserves. The returns of the Tenth Census, that of 1880, showed that there were in use in the United States no fewer than 55,404 water wheels developing a total of 1,225,379 horse-power, or 35.93 per cent. of the total power employed for industrial purposes. In view of the extension of water power plants since 1880, there can be no doubt that the increase in this field will again be considerable even if it has not kept pace with the growth of steam power. Such places as Minneapolis and Appleton are largely the product of the last decade, and there has, moreover, been a very considerable development due to the introduction of the electric light. The last census took no account—for there was none to take—of the use of water power in generating current for light and power; but the special electrical census this year will include hundreds of wheels throughout the country of a total capacity of many thousand horse-power, operated solely in connection with dynamos.

It is, in fact, in the electrical field that the turbine builder must look for much of his new business, and it is certainly a department worth cultivating. Instances like Rochester, or Kearney, or Spokane Falls at once come to mind; and they are destined to be more plentiful as the idea is realized that the energy of our water powers can thus be distributed economically over a very large area by means of wires and motors. The plans for Niagara are now well matured, but there are other propositions even further advanced to the stage of execution. Thus, Col Whittemore, of the Government Arsenal at Rock Island, Ill., in his report to the Chief of Ordnance has submitted plans for the electrical transmission of power from 41 wheels, the dam for which is now being built. His intention is to connect these wheels directly with dynamos, and to carry the current to motors scattered all over the rapidly growing shops. The estimate is made of an expenditure of about $50,000, to start with, for the transmission of current both for light and for power. Some fifteen years ago a Board of Ordnance officers recommended transmission from the wheels by means of rigid shafting continued with wire rope. To-day, however, electricity is seen to be by far the most flexible and economical method, and the carrying out of such a plan will be another exemplification of the great advantages that electricity offers.

We trust that this subject of the electrical utilization of water powers will hereafter command more attention. We know of more than one place where a sure return awaits the enterprising capitalist, and some of them are not far from New York. There are water powers that even electricity cannot reclaim, but leaving such aside, the residue presents a field of magnificent opportunities. An official calculation upon the best data obtainable brings out the extraordinary fact that the rivers and streams of this country, averaged throughout the year, show over 200,000,000 horse-power. At the present time, allowing the total of 1880 to have been doubled, we are using just 1 per cent. With the help of electricity it ought to be at least 5 per cent.

MAGNETIC TELEPHONE CONDUCTORS.

IN another column we have described a novel method by which an inventor hopes to maintain telephonic conversation without the employment of the carbon transmitter, depending solely upon the variation in the magnetic state of the core by the vibration of the diaphragm before it. In order to accomplish this, the inventor converts his entire conductor into a kind of solenoidal magnet by passing the transmitting current around it and back through it. In the lack of definite information as to the length of line thus far operated upon, it would be impossible to predicate possible results; but certain considerations seem to point to difficulties which would be encountered in such an arrangement. While it is well known that a long magnet such as that of the nature described, will give a strong magnetic pole, it is also one which is endowed with great coercive force, in virtue of which it acts very slowly in giving up, or receiving, its magnetism. Thus experiments have shown that a long soft iron wire acting as the core of the magnetizing coil was able to sustain a weight long after the current had ceased. This magnetic retentiveness of long magnets, and vice versa the greater sensitiveness to change of magnetizing current in short magnets, is the principal reason of the general adoption of short magnets in the construction of dynamo electric machinery. We hope the inventor of the telephone system described will soon be able to furnish particulars of its practical operation.

CURRENT AND COEFFICIENT OF FRICTION.

THE important part which the phenomenon of increase in friction between metallic surfaces traversed by a current may play in the future in its application to various purposes makes any contribution on the subject of value at this time. Our columns have quite recently been devoted to the recording of the results obtained by Messrs. Daft, Crosby, Blake and Ries, the last of whom has perhaps carried his experiments farthest in a practical direction. While all of these agree that an effect such as originally pointed out by Mr. Daft takes place, and ascribe it to the production of heat, there is a difference of opinion as to the relative increase of traction obtained with a given current. The latest experiments which we note in another column, and are due to Mr. Levy, go to confirm the results obtained by Mr. Ries, especially on the paradoxical increase of friction due to oiling the rails in circuit. While up to the present time both forms of current, continuous and alternating, have been employed in these experiments, no comparative data has been published, and it would be interesting to see determined the relative efficiency of the two forms of current in that respect. We hope the subject will soon be taken up.

ELECTRIC POWER RATES.

IN our last issue we gave a few illustrations of the manner in which the electric power business had now come prominently to the front as a means of providing daytime work for central stations. It is to be borne in mind that the motor business depends largely for its success upon the rates at which the consumer can secure his current. We have received within the last few days the new schedule of power rates recently adopted by the Brush Company of Baltimore "after a very careful consideration." It is as follows :—

1-10 h. p.	$ 2.50
¼ h. p.	3.00
½ h. p.	5.00
1 h. p.	10.00
2 h. p.	16.00
3 h. p.	21.00
4 h. p.	26.00
5 h. p.	30.00
6 h. p.	33.00
8 h. p	42.00
10 h. p.	50.00

This scale, which goes into effect on July 1, seems reasonable for a city presenting such conditions as Baltimore does, with a large population engaged in a variety of pursuits but not distinctively of the industrial type and not presenting so great a diversification of small industries as one finds, for example, in Boston or Newark. Still the motor business has been fairly well worked up in Baltimore, and there are now 375 motors representing about 200 h. p. of daily consumption of current. With the revised schedule this number and quantity should increase quickly.

Primary Batteries at the Paris Exposition.

WITH this number we bring to a close the official report on primary batteries at the Paris Exposition, by Mr. Carl Hering, which stands as an excellent review of the state of the art at the present time. It is interesting to note the modifications which the Leclanché cell is undergoing. They bid fair to reach in number those which the Bunsen cell has given rise to. The recent introduction here of the Edison-Lalande battery makes the detailed information as to similar cells exhibited at Paris timely. One of the most striking points brought out is the great increase in output of the cell on the increase of its temperature due to the fall in internal resistance. This marked action is suggestive of methods which might be turned to useful account.

Mr. Villard's Electrical Projects.

THERE can be no doubt of the fact that the magnificent field for development by capital that is now presented in the various branches of electric light and power has appealed very effectually to the imagination of Mr. Villard. He is one of those brilliant men of affairs whose insight and foresight, as well as influence with capital, are so necessary to the building up of new enterprises on the large scale ; and now that he has found out by his association with the Edison Company what the opportunities are, he cannot but go forward. His ideas on the subject may be seen in the circular signed by him which we print in this issue. Aside from the general aspects of the situation there touched upon, there is special interest in his utterances regarding the Edison and Thomson-Houston Companies. He thus confirms officially what we have already hinted at more than once as to their friendly relations ; but it by no means follows even now that there is to be, or will be for a long time yet, any actual consolidation and amalgamation. In Boston, some of the papers have gone so far as to effect a wholesale combination, in which such names as Villard, Coffin, Westinghouse and Edison are assembled in a most striking manner. Such an array of genius and talent might well direct such united forces as are thus implied—but the truth is the conditions are not quite all that is stated by the financial writers in question.

Trusts and the Law.

WE print in this issue an article from Mr. C. A. Brown, whose business responsibilities have not prevented him from excelling in the law. He has lately made a special study of the many vital questions involved in trusts, and as the subject is one not less interesting to those engaged in electrical industries than to others with capital and experience invested in plants and factories, we have gladly given space in our columns to his clear, crisp and dispassionate presentation of the case and all that it involves.

The Copper Market.

ELECTRICAL engineers are beginning to look a little askance at the later quotations of the copper market, and do not altogether like the rising tendency that has been manifested. Still, as has been said recently, "a 16 cent market for the product is a tremendous incentive to increase in production," and possibly some relief lies that way by and by. It is interesting to note, in this connection, that the supply of electrolytic copper is steadily increasing. The quantity made in this country last year is said to have been not less than 20,000,000 pounds. New copper producers will greatly increase the supply this year. The notion that the demand from electrical companies for copper is not of a permanent nature has now been very thoroughly dispelled, and the electrical consumption to-day is not among the least important factors in calculations as to prices and supplies.

ELECTRICAL ENGINEERS.

CHARLES J. VAN DEPOELE.

It is but natural that one who has done so much for electric railroads should have been brought up among railway men and railway shops. Charles J. Van Depoele was born at Lichtervelde, Belgium, in 1846, and from an early age displayed an interest in machinery, the taste being inherited from his father, who was for several years master mechanic of the East Flanders Railway shops at Poperinghe. In 1856 young Van Depoele saw the telegraph system of the road put up, and by the time it was completed was perfectly familiar with the apparatus and its modus operandi. He built apparatus of his own of the same nature, and read through every book the college offered on natural philosophy and electricity. When he had reached the age of thirteen his father was so well satisfied that he brought his education to a summary end in spite of the appeals of his professor and the principal of the college. Nothing else would do but an apprenticeship in cabinet making; and the boy was set to work planing rough boards, on the magnificent allowance of five cents per week.

Charles J. Van Depoele.

In the odd hours of his scanty leisure he still built and experimented with electrical apparatus. He made a Ruhmkorff coil with No. 34 wire, using an automatic winder of his own design; but his father found it out, and, believing his prospects to be imperiled, confiscated his books and destroyed the coil. He was then put in charge of an uncle and aunt, who were strictly enjoined to "keep him out of mischief;" and as his working hours often ran from 3:30 a. m. until 9 p. m., it may be surmised that he had little chance to indulge in his favorite pursuit. Still he did contrive to make sulphurous acid before daybreak, and, of course, was found out, the process not being one that lends itself to easy concealment.

At the age of sixteen he had mastered his trade. He was set up in a shop of his own, and soon employed half a dozen men, making all kinds of furniture. He seized every opportunity for study, and went so far as to construct a Bunsen battery of 40 cells. This, however, was carefully hidden from his father, between the joists of the top floor of the house, and there was left when the family removed to Lille, France, in 1864. Young Van Depoele did not take kindly to the furniture industry which his father established there successfully, and therefore was allowed to secure a position in the sculpturing ateliers of Buisine-Rigot, where some 250 artists and artisans were employed. He soon rose to the position of foreman, and also distinguished himself by making an altar for a church at Shanghai, China, an immense piece of carved work sixty feet high by forty feet wide. He now made plenty of money, part of which went to his mother, but no small portion was spent on electrical books and apparatus. The paternal restraint and disapproval were, however, very irksome, and at last he resolved to come to America, where he would be free to gratify his tastes to the full.

He arrived in Detroit in the summer of 1869, and there, with a Belgian friend, started the manufacture of art furniture, thus being a pioneer in that now great and prosperous industry of the West. As the business grew, its income grew, and Van Depoele built himself a battery of 100 Bunsen cells, with which he produced the electric light. From that time on, for several years, despite the wishes and protests of his friends, he spent all of his leisure and much of his ample revenues from the furniture business in electrical experiments. When the Gramme machine was brought out he at once made a dynamo after the description given, and was so much gratified with the results that he constructed several other machines of the same type. So interested was he that, though the day was devoted religiously to his business, he was delighted when the hour came for the men to quit work, and he was at liberty again to try some new experiment.

This state of affairs lasted until 1877, when he built an electrical laboratory and there constructed several large dynamos, with which exhibitions were given. His large shop was brilliantly illuminated by from four to eight arc lights. On one occasion, during a fog, he placed a large arc lamp on top of his shop, and the extraordinary glare brought out the city fire department. In 1878 he lit up Forepaugh's circus, and after that Recreation Park was illuminated nightly for the benefit of baseball enthusiasts. The same year he made a contract to light the front of the Detroit Opera House. One or two propositions were now made to him looking to the formation of a company, but nothing was seriously done until 1881, when, having established himself in Chicago, a strong company was formed, in which Gen. A. K. Stiles was the chief stockholder. Within a year from the start over 100 men were employed in their shops, and a successful business was done, in spite of the competition that now began to make itself felt in this field.

Mr. Van Depoele not only gave attention to the development of his arc lighting system, but investigated the question of electric power, and worked out various devices for "telpherage" and the running of tools by electric motor. A great hobby of his was the propulsion of street cars by electricity, in which his first experiments were made in 1882. His first commercial road was equipped in 1885 at South Bend, Ind., where five cars were run at one time—something never done before, and even then regarded very sceptically. The work thus begun went on apace, and by 1888 the Van Depoele Company had no fewer than thirteen roads in operation on the overhead wire system, the plans and designs for all the apparatus throughout being worked out by himself, and many of the roads remaining in successful operation to this day on the original methods.

In the spring of 1888 the Van Depoele Company sold out their electric railway system, patents and business to the Thomson-Houston Electric Company, of Boston, whose service Mr. Van Depoele thereupon entered as electrician of the railway department. Everyone is familiar with the enormous strides made by that company in electric railway work since that time.

It is worthy of mention that Mr. Van Depoele claims to have been the first to run a number of cars from a single source of constant potential, using separately excited generators. In the fall of 1885, when the South Bend road was constructed, he had five cars in operation, four of 7 h. p. and one of 10 h. p., the motors being under the car floor. At the time he did this, no road, it is said, had more than two cars at most in operation at the same time.

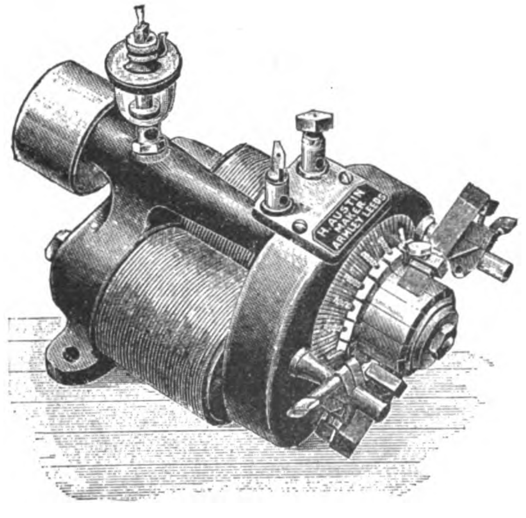
Not only has Mr. Van Depoele developed the lighting and traction systems bearing his name, but he has produced a great number of commutatorless motors, both rotary and reciprocating, the latter being specially adapted for rock drilling. In fact, some of his drills were tested for coal mining as far back as 1885. He has lately devoted considerable attention to the subject, and promises to bring out soon some perfected apparatus. These drills are operated by direct pulsating currents, require no commutation, and owing to their extreme simplicity are not liable to get out of order. Mr. Van Depoele is applying the same principle to forge hammers, riveting, etc.

This brief record does bare justice to the persistency with which Mr. Van Depoele carries out his inventions and ideas. He is indefatigable, and is also able to maintain his good nature and courage amid disheartening difficulties and setbacks. In capacity for hard work he is not excelled.

The portrait of Mr. Van Depoele on the preceding page is from a recent and faithful photograph.

AUSTIN'S INFANT DYNAMO.[1]

Under the name of the Infant dynamo, Mr. H. Austin, of Armley, Leeds, is introducing a machine which he hopes may meet the demand for small dynamos, having equal merits with the larger ones as far as regards good output for power absorbed. He commences where other makers leave off, namely, at one unit, the range of sizes being 1,000, 700, 400, 200, 100, and 50 watts. These are all made alike in every detail, differing only in size.



Austin's "Infant" Dynamo.

The armature core is made up of thin best Swedish charcoal iron rings (No. 18 B.W.G.), accurately turned both inside and outside by special machinery. The sharp corners left on in turning are all carefully ground off each separate ring, which is then coated on both sides by a varnish made up of very thin shellac varnish, in which is mixed some fine plaster of Paris. The core is then built up to the required depth, the separate pairs of rings, while under pressure, being carefully tested for insulation, and mounted on a strong spider of hard brass. The core is then well insulated, and wound in the Gramme fashion. The commutator is made up of segments of brass of a special quality (carefully insulated with asbestos or mica), and has a good wearing depth. The field magnet cores are made of best Swedish iron, carefully annealed, and are screwed into the pole-pieces—the pitch of thread being very small—a method which gives a very good contact between the two surfaces. The yokes are very massive, having a sectional area three times that of the cores. The bearings are of very hard phosphor bronze, and are of good length. Each dynamo is fitted with a sight-feed lubricator. The used oil finds its way by suitable passages into the oil dish under the yoke of the magnets. There is only one lubricator to each dynamo, the oil entering between the two brushes and working outwards, thus keeping the bearings perfectly clean.

ELECTRIC MOTORS AND CHURCH ORGANS.

It is now some time since that the great organ of St. Paul's Church, in this city, was equipped with an electric motor for blowing the bellows, and the success which was there attained in evenness of pressure and volume has called forth the approbation of all who have had occasion to witness the operation of the simple but effective installation.

Indeed so successfully has the work been accomplished that the C. & C. Electric Motor Co., the designers of this plant, have been called upon to make similar changes in nearly a dozen of the largest churches in this city, including St. Patrick's Cathedral, St. Thomas's, Calvary, Trinity and others.

In a handsomely illustrated catalogue just issued by the company there are described the most prominent of these installations, each one of which has demanded the fulfilment of some particular conditions, and the successful accomplishment of which attests again the adaptability as well as flexibility of the electric motor in all situations.

As an example of this we may cite the case of the large organ in old Trinity, on Broadway, facing Wall street, in this city. The scale of the pipes in this organ is larger than that of any other in this country, and many stops have from time to time been added to it without at the same time enlarging the bellows. The latter, as originally designed, were too small for the work which they had to do, and the needed addition to them was never made. To answer satisfactorily, therefore, this great demand was indeed a problem, but the electric motor as installed satisfies all the requirements put upon it.

The organ is located virtually in the main body of the church, the large ornamented pipes that form its front merely shutting out the view of the more unsightly portion behind, and any noise made there is instantly caught by the arch over head and made to reverberate through the building. Even here, however, the electric motor performs its work so noiselessly that nowhere in the church is the slightest sound from it perceptible, a result which it is safe to assume that electricity alone could attain.

The accompanying engraving shows clearly how the motor is attached to the organ. The belt from the motor runs to a large pulley on the counter shaft on which are two driving pulleys leading to pulleys on the driving shaft. Each bellows controls a part of the organ, and they are both automatic in their working and when full are made to cut off. When, however, one part is used beyond its capacity, an automatic arrangement opens a connection between both bellows, causing the secondary bellows to aid the primary, thus insuring an abundance of wind without straining either bellows. The motor is started from the key-board, and since full power can be obtained at any instant, a power of tone never before heard surprises even those who are most familiar with this grand old organ.

In the installation at St. Patrick's Cathedral the small organ is so placed that the motor has to stand in the very chancel, but it is impossible to perceive the slightest sound from it. The speed of the motor in this case is regulated by a resistance box. The lever on the box is connected to the bellows, and their movement causes more or less resistance to be thrown into the motor, thus automatically regulating its speed to conform with the needs of the organ.

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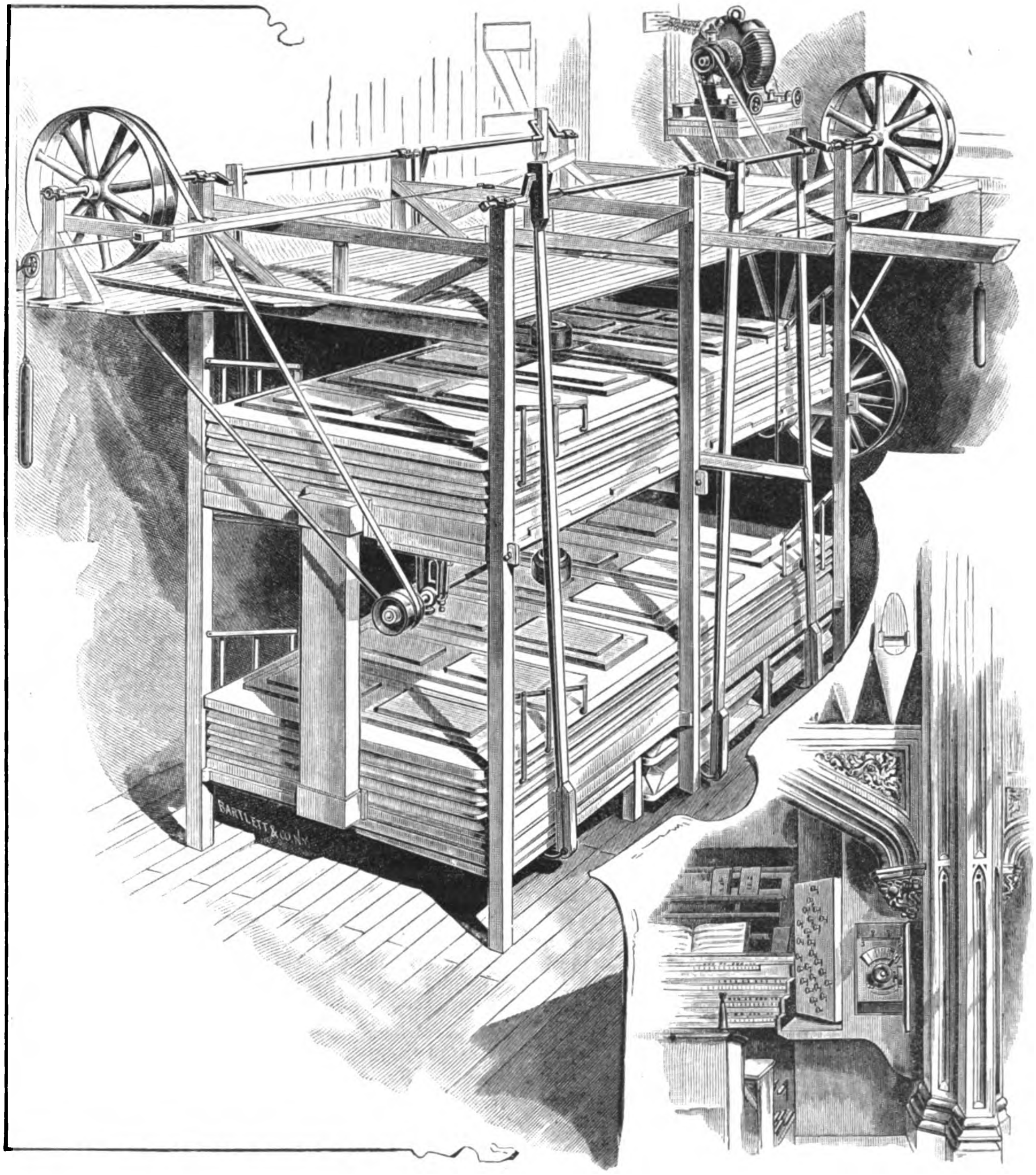
[1] London Electrical Review.

Perhaps the most compact plant yet installed is that in the Church of the Holy Communion. The pulleys, counter shaft, driving shaft and motor are all placed under the bellows, and the whole arrangement occupies a space about five feet by two.

The installation at the Collegiate Church at Twenty-ninth street and Fifth avenue very neatly solves the problem of a compound organ. This organ has two bellows; one supplies the entire organ with the exception of one register, which is supplied by a high pressure bellows. The arrangement is such as to throw this bellows into automatic action when the stop is drawn, thus making the supply of wind available. When the stop is put in, the automatic arrangement is checked and the supply is cut off.

It is needless to say that the C. & C. Company, who have made a specialty of this class of work, have relieved the organists of the churches they have equipped of a constant source of annoyance, and the latter have been most unanimous in testifying to the superior qualities of the electric motor as a source of power for their particular needs.


BARTLETT & CO. N.Y.

Church Organs Blown by Electric Motor.

THE GOVERNMENT AND TELEGRAPHY.

The Postmaster-General has issued an order fixing the rates on Government telegrams for the fiscal year, beginning July 1, 1890. The rates are exactly the same as those of the present fiscal year. That is, on day messages, ten cents for ten body words, for not over 400 miles, and half a cent for each additional word. Fifteen cents for ten words between 400 and 1,000 miles, and three-quarters of a cent for each additional word. For a greater distance than 1,000 miles half a cent extra for each word added to the price of the message for between 400 and 1,000 miles. For night messages fifteen cents for twenty body words for all distances, and half a cent for each additional word. For signal service weather reports two and a half cents for each word sent over each circuit established by the Chief Signal Officer.

THE FALLACY OF MUNICIPAL CONTROL OF ELECTRIC LIGHTING.

BY M. J. FRANCISCO, PRESIDENT, RUTLAND, VT., ELECTRIC LIGHT COMPANY.

I FIND in THE ELECTRICAL ENGINEER of June 4th an article by Victor Rosewater, of John Hopkins University, in which an effort is made to show the benefits to be derived by a city owning an electric light plant. I understand that this gentleman is one of Prof. Ely's pupils, and of course he is giving the public the professor's views and teaching. The author takes the position that the interest of the stockholder and the citizen are directly antagonistic. If this is the case, is not every corporation in this country in the same condition? Is not a stockholder in an electric light company governed by the same conditions that control other enterprises? Mr. Rosewater claims that hired politicians, whose tenure of office is but for one year, without experience or knowledge of the business and with no financial interest in it, with the exception of their salaries, will give the tax-payer better service than the private corporation! The manager of an electric light company, however, is personally interested and knows that its success depends upon his furnishing the best service at fair rates. Now, in order to accomplish this, it is evident that he will bring to his aid all that years of experience have taught him is best in electrical apparatus, together with the latest inventions and improvements.

If a city can sell electricity why not sell groceries and dry goods? For the merchant makes his profit while the city would sell without a profit. Of course with this plan the business of individuals and of private corporations would be destroyed, and their property, upon which present taxation is based, would be swept away. Under such conditions where would the municipal salaries come from?

There is one point which the author of that article wisely omits to mention. A city invests thousands of dollars in electrical apparatus as at present manufactured. With the rapid strides now being made in inventions, one year hence all machines may be so changed or improved that it would be a direct loss to use the present style. What would the city do? Use the old style, with the cost of producing the lights double what it would be with the improved apparatus? Or throw it out and buy another outfit, and tax the people to pay for that also? If the city own the plant they assume these chances. If a private corporation, it has to provide for just such contingencies, and these conditions have compelled many an electric light company to run years without a dividend or any return upon their investment.

Special stress is laid by Mr. Rosewater upon the statistics collected about a year ago by the Scranton, Pa., Council, and in that list the cost of all night lights in Topeka, Kansas, is quoted at $72 per year. I have a letter signed by the Mayor of Topeka, in which he states that the cost of operating the all night lights has been $11 per month, or $132 per year. Here is an illustration of the value of the Scranton Council's statistics, and also a sample of many garbled statements pretending to show the cost of municipal lighting. Why try to conceal the facts by furnishing only *part* of the expense of the city's plant? Every one knows that if forty or fifty thousand dollars of the taxpayers' money is invested in an electric plant, interest on that investment must be charged as part of the expense. If that money had been loaned to an electric light company, would it not have produced an income to the city? Everyone familiar with the electric light business understands, full well, that the depreciation by use is not less than 10 per cent. per year, and that this is part of the yearly expense. The tax-payers, if the city own the plant, must meet these expenditures the same as an electric light company. Trying to ignore or conceal the truth does not aid their cause in the end. Yet, in all the comparisons made in the article referred to, the prices quoted as charged by the electric light company include these items, while they are all omitted in the cost of lights furnished by the city.

Bay City, Mich., is cited as an example of the success of municipal lighting. The Council of Bay City appointed a special committee to investigate the expense of city lights, and they submitted a report showing that the city was running 137 lights at a cost of $59.42 each per year. This did not include taxes, water rates, interest or depreciation. Including interest, 5 per cent. on $35,000, cost of plant, taxes and water rates, 2½ per cent., 10 per cent. depreciation, the cost was $104 per year each lamp, running only dark nights. A short time since, during a thunder shower, the city was left in darkness, because the city superintendent was afraid of burning out an armature if he ran the lights. What would be the result if an electric light company left the city in darkness every time the superintendent noticed a storm approaching? A gentleman passing an evening in Bay City recently, inquired why they did not have street lights, and the answer was they did have them, and sure enough, at nine o'clock, they started the lights!

Still the price charged by electric light companies for first-class service is compared with such service as this, and if the private company's lights are out for an hour, or not up to full candle power, a rebate is demanded. Before Mr. Rosewater quotes the cost of lights for any other cities he had better obtain the facts, and not lead the public to think that there is a reason why the true data does not appear.

"It may easily be seen that prices in this industry are not governed by the cost of production. The great difference between the average cost to cities illuminated by contract and to those furnishing their own light gives good ground for this inference." Thus, Mr. Rosewater. But is it singular that prices in various cities should differ? In one city the lights are burned until midnight, in another all night; while one uses steam power, the other water; one uses 1200 candle-power lamps, the other 2,000. In one place fuel costs $1 per ton, while in the other it costs $6 per ton. Of course under these varying conditions prices cannot be the same. The very fact that the article referred to gives the cost of lights in cities owning the plant, in comparison with cost of lights furnished by private companies, and does not give the information embodied in the above queries, shows the unfairness of the comparison and the attempt to misconstrue the real facts, leading the public to think the conditions in each place quoted were the same. How is it that in the list furnished of cities owning their own plants, in one it is $23.61 per year, while in others it is $60, $72 and $100 per year? Why this difference in various cities? Why not apply the author's own argument to municipalities as well as electric light companies and claim that city "authorities are swindling the taxpayers because the cost of producing the light is not the same in every city owning a plant?" The committee on manufactures of the legislature of Massachusetts were sent to Philadelphia, Richmond, and Alexandria to investigate the municipal lighting of those cities. They found that the actual loss to the city of Philadelphia last year was $104,145.26, while the annual loss to the city of Richmond was $42,405.97; and the committee reported against Massachusetts adopting such methods. Yet this university man says: "A committee of the select council of Philadelphia was so highly pleased that the municipal gas works are not only paying expenses under its new management, but actually earning a profit, that it reported an appropriation of $300,000 for the extension of the public lighting system to the field of electricity. It was only owing to the influence of the electric lighting corporation that this item was stricken off the appropriation bill." Politicians are generally pleased if they can convince the public that they are the men to keep in office and handle the taxpayer's money. If the electric light companies, by their influence, prevented the city of Philadelphia from wasting $300,000, as the author of that article says they did, the taxpayers and citizens ought to tender them a vote of thanks.

Danvers, Mass., is quoted as one of the cities owning its own plant, and advocates of municipal ownership claim that the cost there is only $45.37 per year to run a 1,200 candle power lamp. What are the facts? Danvers is burning seventy-three 1,200 candle power lamps. The actual running expenses last year were $3,500. Interest on $15,000, cost of plant, at 6 per cent is $900; depreciation by wear etc., at 5 per cent is $750; taxes which the town would have received from the private company are $100, making the total cost, $5,250, or $71 per lamp per year for 1,200 candle power lamps 300 nights until midnight.

The figures given for Danvers show the cost where the city owns the plant at $71 per year, while, by Mr. Rosewater's own list, he shows that private corporations are furnishing Yonkers, N. Y., all night lights for $60 per year; Racine, Wis., all night for $70; Lafayette, Ind., all night for $50. It costs every one of these cities less for all night lights than it costs the city of Danvers for lights until midnight. The fact that these companies are compelled to furnish their lights at such non-remunerative prices, shows conclusively the inconsistency of Mr. Rosewater's claim that electric light companies are a monopoly.

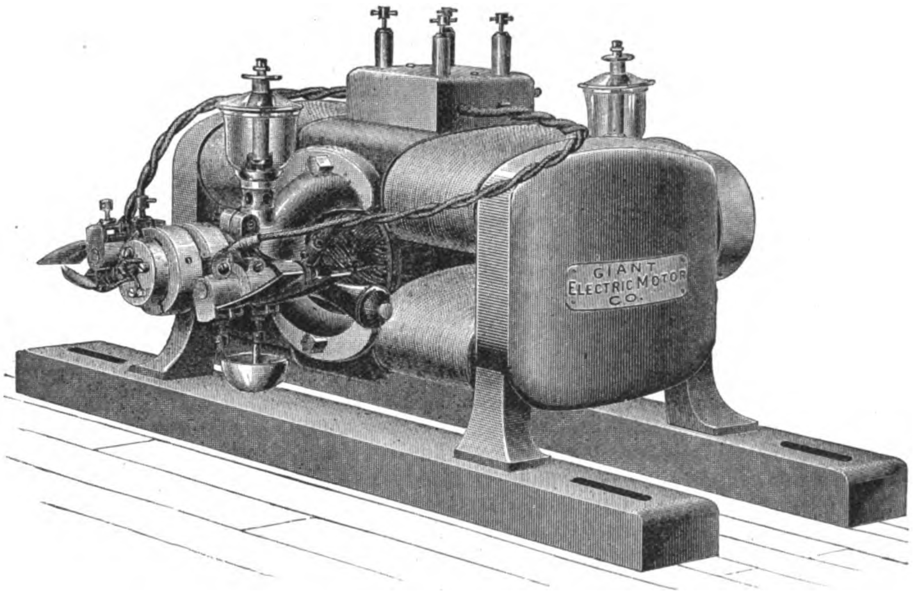
Several cities owning plants, have found by actual experience that the service and expenses relating to the same were unsatisfactory, are now considering the advisability of abandoning the control of the plant, and are negotiating for contracts with electric light companies to light their streets. Philadelphia, owning an immense gas plant which Mr. Rosewater says the "Select Council were wonderfully pleased with, because they were making a profit," has contracted with electric light companies to light the streets for $177 per year each lamp, or more than three times the amount he claims as the average cost for those cities producing their own lights. The taxpayers of Philadelphia have had an experience with both plants, and evidently think any price a private corporation will offer is cheaper and better than municipal control.

No sane or fair minded man will, with the corruption and fraud practiced by politicians at the present day, attempt to prove that it is for the best interest of the taxpayer to place faith in the honest or conservative management of any enterprise which can be manipulated in the political arena for the advancement of the men in power. The histories of New York, Philadelphia, and many other cities are samples of such methods and their purifying effects upon politics. Hypothesis and theory may do on paper, but actual results obtained by practical application and experience are the only reliable data upon which to base any statement relating to the cost of street lighting. In every case these have shown, where all the facts are given, that it has been for the best interest of the citizens and tax payers to contract with an electric light company for lighting the streets of any city.

THE CHAPMAN INCANDESCENT DYNAMO.

We illustrate in the accompanying engraving the Chapman dynamo of the Star Electric Co., of Bridgeport, Conn., in which special attention has been given to the mechanical and electrical design. The armature winding, it will be noted, consists of two coils wound at right angles to each other and connected to a pair of two-part commutators. In order to reduce as much as possible the care required by the commutator, the latter is made of a cylindrical piece of hard insulating material, keyed to the shaft at one end, and two pairs of semi-circular segments of brass secured thereto, and two pairs of semi-circular segments of composition metal secured to the first-named segments by one screw in each segment.

When, in the course of time, the commutator has become worn, it is only necessary to remove the four wearing segments, which can be done in a few minutes with the aid merely of a screw driver, and replace them by a fresh set. This avoids the necessity of removing the armature in order to turn the commutator true.



The Chapman Dynamo.

The two independent coils on the armature generate current which is conveyed by flexible conducting wires to two corresponding pairs of binding posts on the top of the machine; thus, there are two independent sets of terminals from which two independent sets of mains may be run to the lights. Each set of mains thus has an armature coil by itself, feeding the current into it, and each armature coil has an independent circuit to act upon.

The machine illustrated is built in sizes ranging from 10 to 200 16 c. p. lamps. The company also manufacture the Chapman motor, of the consequent pole type with Siemens armature, and ranging from ¼ to 4 horse-power.

WESTERN UNION POLES.

The greater portion of the cedar telegraph poles used by the Western Union company come from Michigan. From forty to two hundred men and nearly forty teams are employed in gathering the poles and putting them in proper shape. The poles range from 26 to 60 feet in length, and are worth from $1 to $7 each.

TRUSTS AND THE LAW.

BY C. A. BROWN.

THE present tendency of public sentiment is strongly against Trusts, as are called combinations of corporations entered into for the purpose of controlling business and prices, and we may assume that unless public sentiment changes, or the incentive which induces these combinations fail, some method will be found, if necessary by alteration of the fundamental law to restrain and govern them, provided the legal means to accomplish this do not now exist.

Our inquiry now, therefore, is directed to ascertaining the extent and the principles upon which the law as it at present exists, prohibits private corporations organized for business purposes from entering into combinations with a view to controlling business and prices.

Corporations have the same legal limitations as individuals, and in addition thereto some which arise from their special nature and from the law to which they owe their creation.

We will examine then the prohibition which the law imposes upon individuals to prevent their combining to control business and prices, and then the additional disabilities of corporations.

The offences of engrossing, forestalling and regrating, defined and forbidden by the statute of 5 and 6 Edward VI, cap. 14, are now obsolete, and are merely worth mentioning as showing how changing conditions of life and trade modify the laws. Whether these offences were crimes at common law has been disputed. It is probable that they were not, but were made crimes by statute in the reign of Edward the Sixth.

It is a well settled rule of law that contracts in general restraint of trade are illegal and void (which means that a contract by which one of the parties has unduly restrained himself from following a trade or business, will be declared illegal).

The foundation of this rule lies in the advantage to the community of having every person at liberty to employ himself in that department of labor in which his personal efforts will be likely to add most to the aggregate productions of the country, and "that all the various trades and employments of society should be employed each in its due proportion,—a result with which the exclusion of any individual from his accustomed pursuits has a tendency to interfere." (Lawrence *vs.* Kidder, 10 Barb. 641.)

Originating as it did "when trade and the mechanical arts were in their infancy, and it was deemed a matter of the greatest public importance to encourage their growth, and to prohibit contracts which tended to abridge them" (Wright *vs.* Ryder, 36 Cal. 342), this rule has been modified, and seems likely to disappear practically in great trade centres. A convenient method of softening the asperity of this rule, lies in the distinction which is drawn between a contract in general and one in partial restraint of trade. The latter will be upheld by the courts under proper circumstances, and there seems to be a disposition on the part of the courts to restrict more and more the application of the doctrine, by extending more and more the limits within which a contract in restraint of trade will be considered partial. In the case of Diamond Match Co. *vs.* Roeber, 106 N. Y. 473, the New York Court of Appeals upheld a contract in which the defendant had agreed to refrain from competing with the plaintiff in a certain line of business in all the States and Territories of the United States, *except Nevada and Montana;* and decided also that the motive for the restraining agreement is not a test of its validity, since "a party may legally purchase the trade and business of another for the very purpose of preventing competition, and the validity of the contract, if supported by a consideration, will depend upon its reasonableness as between the parties." The application of this rule to agreements between several producing establishments by which one or more of them agrees to refrain from further production, is obvious, and it should be observed that the court in the case of Diamond Match Co. *vs.* Roeber, *supra*, says "that combinations between producers to limit production and to enhance prices, are or may be unlawful, but they stand on a different footing." The distinction being evidently in the purpose of the combination. If innocent and not prejudicial to public interests it will be sustained.

But in spite of the development of judicial opinion on the subject of contracts in restraint of trade, the cases, ancient and modern, agree that a combination, the tendency of which is to prevent general competition and to control prices, is detrimental to the public, and consequently unlawful. It should be observed that the question as to the legality of a contract in restraint of trade, arises solely between the parties to the contract; on application of one of them the court declares the contract invalid. Consequently combinations based upon such agreements depend for their continued existence upon the insecure tenure of the will of the parties, and the harmony of their relations.

Another question which has a bearing upon the agreements of producing persons and concerns to combine for the control of business and prices, is as to the legality at common law of a joint stock company without legislative sanction, with transferable shares. Such an association, which is in fact a partnership, would seem to be legal unless it can be shown to have a purpose which is not legitimate, although a contrary conclusion has been reached in Illinois and Louisiana. The following is the substance of the propositions of Mr. Lindley on this subject in his work on Partnership:—That it is not illegal for any number of persons to enter into a contract of partnership, nor for them to agree that when one retires a person who is not a member of the firm, but who is willing to become one, shall take his place; nor that the new comer may be selected by the one retiring; nor that the outgoing and incoming partner may agree upon the terms of withdrawal and entrance, if these terms are not in themselves illegal; nor is it illegal for the members of a firm to assume a name, and to agree that the management of its affairs shall be entrusted to a select few, and that these select few shall have power to make rules which others shall be bound to obey.

It would seem, therefore, that objections to associations formed under a trust agreement, such as that under which the Sugar Trust operates, on the ground that they usurp the functions of a corporation, are not well founded. To be open to this objection there must be an assumption of the qualities of a legal person as, for example, to sue or to be sued in a corporate name. Avoiding this usurpation of corporate power the legality of such an association depends upon the legality of its object. If its object is to keep the supply steady and adequate to public wants, to avoid overproduction, to promote economy of administration and reduce the cost of operating, it is innocent and for the best interests of the public, and therefore legal. But if, on the other hand, the object of such an association, express, or implied, is to create a monopoly and enhance prices, it is against public policy and illegal.

In considering this question with reference to the special limitations imposed upon corporations, it is desirable to glance briefly at the salient features of the nature of a corporation having a bearing on this subject.

"A corporation is a body consisting of one or more natural persons, empowered by law to act as an individual and continued by a succession of members."

A corporation owes its franchise to the sovereign power (in this country, the legislature), or to prescription which pre-supposes a grant from such power.

There are two methods in which corporations are created: first, by specific grant of the franchise to the members; second, by a general grant which becomes available for particular persons when they organize themselves in accordance with the provisions of the grant.

The following powers and privileges are said to pertain to all corporations:—First, the power of perpetual succession of members; second, the power to sue and to be sued in the corporate name, and to transact in that name all such business as is within the intent of the grant; third, to purchase, take and hold property, and to sell and convey the same except as may be forbidden; fourth, to have a common seal under which to transact its business, and to alter the same at pleasure; fifth, to make by-laws for its government, provided they be not unreasonable or inconsistent with law.

In this country corporations are created by state legislatures alone, except that the Federal Government may create them in the Territories and the District of Columbia, though even in this restricted territory the general government does not usually assume the prerogative, but leaves the creation of corporations to the local legislature, when there is one. Strictly speaking, corporations exist only in the state in which they are formed, but the principle of comity between the states has modified the strictness of this rule, and practically permits to corporations the full exercise of power in other states which they may exercise lawfully within the state in which they have received their charter. This comity, however, is limited necessarily. In all cases any general policy of the state, into which a foreign corporation comes to do business, must limit the requirements of the comity.

A corporation is obliged to confine its operations to the sphere of the authority conferred upon it by the legislature. Acts beyond this are *ultra vires*. Thus, one corporation cannot consolidate itself with another, unless by express authority of the law, and the directors of a company cannot dispose of its franchises, and thus wind up the corporation, for the directors are elected to continue the corporation, not to destroy it.

The granting of a charter by a legislature and the acceptance of it by the incorporators, constitute a contract which is inviolable. This fact has led to provisions in constitutions making a charter subject to alteration, amendment and repeal, at the will of the legislature. Unless this right is reserved by the constitution, or in the general or special incorporation act, the legislature has no right to alter, amend or repeal the charter of a corporation. Whether its charter is amendable or not, it is subject to the general police powers of the state.

Although corporations are said to be immortal, their existence may be brought to an end. First, when the corporation is limited by its charter to a certain period of time, and that period has elapsed; second, when right to repeal its charter is reserved, and in accordance with this right the charter is repealed; third, the company may voluntarily surrender its franchises; fourth, a corporation may cease to exist by forfeiture of its franchise. This forfeiture can only be worked through the raising of the question by the state. These are practically all the methods which need be considered.

Foremost amongst the principles limiting the power of corporations to combine for the control of business and prices, is that stated by Chief Justice Savage, in the Fulton Bank case, as follows:—"They (corporations) have no powers but such as are granted, and such as are necessarily incident to the grant made to them. Corporations at common law have certain powers, but not such as would authorize the forming of a partnership or the consolidation of two corporations into one." The legal penalty for transgression of this rule would be the forfeiture of its charter and dissolution of the corporation. "A corporation may incur a forfeiture of its franchises by the doing of an illegal act. Any act of a corporation which is forbidden by its charter, or by a general rule of the law, and, strictly, every act which the charter does not expressly or impliedly authorize the corporation to perform, is unlawful; and if the doing of such act is an injury to the public, it may be sufficient ground for declaring a forfeiture of the corporate franchises." (2 Mor. Priv. Corporations Section 1024.)

Hence it appears that a corporation has not the authority to enter into any partnership arrangement, even though such partnership arrangement would have been lawful between individuals.

In order to escape the consequences which follow such unauthorized combinations on the part of corporations, the form of Trust Agreement, of which that forming the Sugar Trust is a representative, has been devised. Taken in their order the principal features of this deed are: first, statement of the objects; second, agreement of the parties to the deed, in the first place, to organize corporations of such separate organizations as are partnerships, and in the second place, to surrender corporate shares to a board of eleven persons having certain powers; fourth, that the stockholders surrendering their stock shall receive in lieu thereof certificates signed by the board; fifth, division of the profits proportionately among the holders of the board certificates.

The question arises whether such an instrument as this, purporting as it does to be an expression of the act of the stockholders as individuals, is really such in law, or is in law what it is in purpose, an agreement of the corporations. In the discussion of this question, in the opinion of Barrett, J., in the case of The People *vs.* North River Sugar Refining Co., he says: "We now come to the legal question, is this a combination of corporations, or merely a combination of stockholders? The defendant claims that unless authority to sign the trust deed, given by the directors of each corporation at a regular board meeting, is affirmatively proved, the acts complained of are not corporate acts. * * * * . * * The accumulation of evidence points irresistibly to the complete practical identity of shareholders and corporations, and it is quite impossible to sever the acts of the persons solely interested in these corporations from those of the corporations themselves. The purpose to effect corporate combination cannot be disguised. * *"

"A corporation, or a body politic, or a body incorporate," says Mr. Kyd, "is a collection of many individuals united into one body, under a special denomination, having perpetual succession under an artificial form, and vested by the policy of the law with capacity of acting in several respects as an individual." It is really an association of persons, and the word "corporation" is but a collective name for the corporators or members. (1 Mor. Priv. Corp. No. 1, 227,474.) The shareholders vested with the corporate powers are the body corporate, corporation or company. (Taylor Corporation Section 50.) * * * * Mr. Morawetz puts it clearly when he says that "while a corporation may from one point of view, be considered as an entity without regard to the corporators who compose it, the fact remains self-evident that a corporation is not in reality a person or a thing distinct from its constituent parts, and so the acts of the collection body are the acts of the corporation, and if unlawful will work a forfeiture."

"When the whole body of stockholders offend the law of the corporate being, the corporation offends. * * The directors are but the agents of the corporation to manage its affairs, and carry out the purpose and object of its formation. They are only authorized to do such things as are directly or impliedly directed or authorized by the charter. The directors of this defendant could not have bound the corporation by the deed in question. That deed involved momentous changes in the life and destiny of the corporation, and in the relations of its shareholders, which were entirely foreign to the general management of its business."

If it be concluded that agreements such as the one under consideration are corporate agreements, they come within the rule which prohibits such partnership arrangements on the part of corporations, and the legality of such combinations need not be further considered.

But another method by which the same result is endeavored to be reached, is the purchase by one corporation of the capital stock of other corporations. A representative instance of this method is that of the Chicago Gas Trust Company, which was considered by the Supreme Court of Illinois in the case of The People *ex rel.* Peabody *vs.* Chicago Gas Trust Co.

The Chicago Gas Trust Company was organized under the general incorporation law of the State of Illinois, and its object as appears in the statement filed with the Secretary of State, was: first, the erection and operation of works in Chicago, and other places in Illinois, for the manufacture, sale and distribution of gas and electricity; second, to purchase and hold or sell the capital stock of any gas or electric company or companies in Chicago, or elsewhere in Illinois.

In the decision of the Supreme Court of Illinois, Magruder J. says: "There are two views which may be taken of the power to purchase and hold the capital stock of other gas companies as designated in said second clause. Must it be regarded as an original, independent power, intended to exist exclusively and in addition to the power named in the first clause, or may it be considered as merely ancillary to the other power of maintaining and operating works for the manufacture and sale of gas? If the latter view be correct, the main object for which the Gas Trust Company was formed would be that it might itself maintain and operate works for the manufacture and sale of gas, while the purchase of shares of stock in other companies would be merely a subordinate object, incidental only to the main purpose of the corporate formation. * *

Can the power to purchase and hold the stock of other gas companies be lawfully exercised by the appellee as incidental to the main purpose of maintaining and operating works for the manufacture and sale of gas? Corporations can only exercise such powers as may be conferred by the legislative body creating them, either in express terms or by necessary implication; and the implied powers are presumed to exist to enable such bodies to carry out the express powers granted, and to accomplish the purposes of their creation. * * * * * *

An incidental power is one that is directly and immediately appropriate to the execution of the specific power granted, and not one that has a slight or remote relation to it. * * * * * * *

Where a charter in express terms confers upon a corporation the power to maintain and operate works for the manufacture and sale of gas, it is not a necessary implication therefrom that the power to purchase stock in other gas companies should also exist. "The right of a corporation to invest in shares of another company cannot be implied, because both companies are engaged in a similar kind of business." (1 Mor. Priv. Corp. Section 431.) * *

If, then, the power to purchase outside stocks cannot be implied from the power to operate gas works, and make and sell gas, a company to whom the latter power has been expressly granted cannot exercise the former without legislative authority to do so. This is the law as settled by the great weight of authority. Boone on the Law of Corporations, says: "Without a power specifically granted or necessarily implied, a corporation cannot become a stockholder in another corporation, and especially where the object is to obtain the control or affect the management of the latter."

"In Green's Brice's Ultra Vires it is said: 'In the United States a corporation cannot become a stockholder in another corporation unless by power specifically granted by its charter, or necessarily implied in it." So also 1 Mor. Priv. Corp. (sections 431 and 433) says: "A corporation has no implied right to hold stock in another company for the purpose of controlling its management. * * * A corporation cannot, in the absence of express statutory authority become an incorporator by subscribing for share in a new corporation, nor can it do this indirectly through persons acting as its agents or tools." The authorities referred to by these text writers sustain the conclusions announced by them. It has been held in many cases that, "in the United States corporations cannot purchase, nor hold, nor deal in the stocks of other corporations unless expressly authorized to do so by law;" and that, "one corporation cannot become the owner of any portion of the capital stock of another corporation, unless authority to become such is clearly conferred by statute.'

* * * * * * * *

"The power to purchase and hold stock in other companies must be the subject of legislative grant, if not in all cases, at least in cases where it cannot be implied from the powers expressly granted. The general incorporation law contains no grant of such power by the legislature. Can a corporation organized under that law be clothed with such a power by merely naming it in the statement filed with the Secretary of State? We think not.

* * * * * * * *

"We come now to the second view of the right to purchase and hold the stock of other companies. * * * Both were designed to be of equal importance, and to be carried out independently of each other.

* * * * * * * *

"Manufacturing and selling gas is one kind of business; dealing in stocks is another and different kind of business. If it appeared that the appellee was engaged in both under its present charter a serious question of fact arises as to the power to organize one corporation for two distinct purposes under the general incorporation act of this state.

* * * * * * * *

"The general incorporation act provides "that corporations may be formed in the manner provided in this act for any lawful purpose, except banking, insurance, real estate, brokerage, the operation of railroads, and the business of loaning money." The purpose for which a corporation is formed under the act, must be a lawful purpose. So far as appellee was organized with the object of purchasing and holding all the shares of the capital stock of any gas companies in Chicago or Illinois, it was not organized for a lawful purpose, and all acts done by it towards the accomplishment of such object, are illegal and void."

Another limitation to the power of private corporations to combine is thus stated by Justice Miller in Thomas *vs.* The Railroad Co., 101 U. S. 71:

"When a corporation, like a railroad company, has granted to it by charter a franchise intended in large measure to be exercised for the public good, the due performance of these functions being the consideration of the public grant, any contract which disables the corporation from performing these functions, which undertakes, without the consent of the state, to transfer to others the rights and powers conferred by the charter, and to relieve the grantees of the burdens which it imposes, is a violation of the contract with the state, and is void as against public policy."

So that unless expressly authorized to do so a corporation which owes a duty to the public cannot lease or transfer its franchises, nor mortgage them, nor consolidate with another company. In the case of a consolidation, by which is meant the formation of one corporation by the shareholders of several corporations, and the dissolution of the latter, it is important to inquire what may be the effect of this act on the property rights and liabilities, both of the original companies and of the corporation resulting from the consolidation.

As associations of private corporations can only take place when authorized by statute, it follows that the effect of a consolidation is controlled by the statute under which it takes place. Usually the new corporation is invested with all the rights and franchises of the consolidating companies. The new corporation is also generally liable under the same obligations incurred by either of the consolidating companies.

Consolidations of corporations can be effected, therefore, without losing the rights and liabilities of the consolidating companies, when so authorized by statute and by the unanimous consent of the stockholders. A majority of the stockholders can effect a consolidation, provided the charters of the corporation, or any general law in force at the time when the corporation was formed, provides that the corporation may consolidate with other companies, such charter or such general law being considered to enter into the fundamental contract between the shareholders.

It follows that consolidations of corporations are limited to those companies existing in a single state. No such consolidation could be effected between corporations existing in different states.

Briefly, then, it is not a criminal offence at common law for persons or corporations to combine to control business and prices.

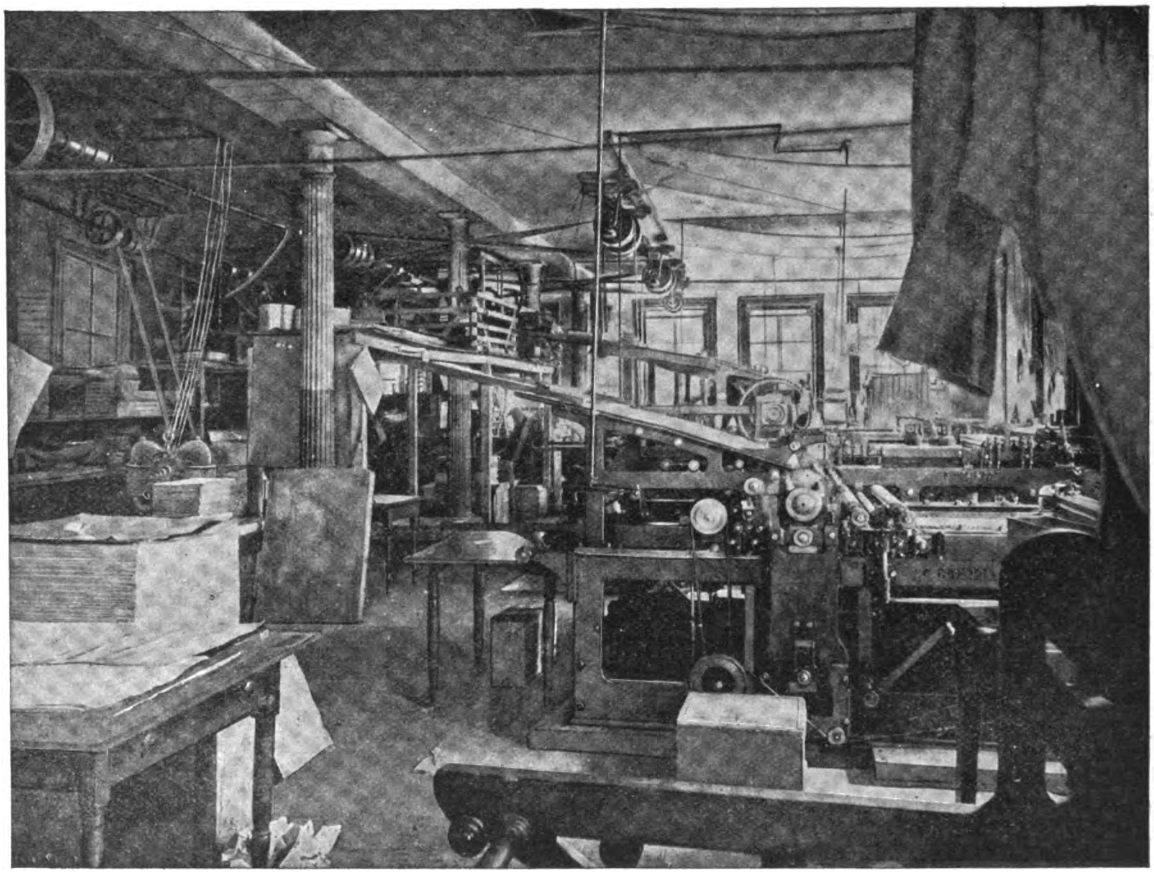
Contracts in general restraint of trade are void, and will not be enforced by the courts.

Joint stock companies are legal if their objects are so.

A corporation must confine its operations to the sphere of authority conferred upon it by the legislature. It can not consolidate with another, nor dispose of its franchises, and thus dissolve, except by express authority of law.

A corporation cannot enter into a partnership unless expressly authorized to do so, and an agreement of all the stockholders of one corporation with all the stockholders of another corporation, such as that which forms the basis of the Sugar Trust, is legally the same as the agreement of the corporations, and renders the charters of the corporations liable to forfeiture.

A corporation cannot legally purchase and hold the capital stock of another corporation in order to obtain the control or affect the management of the latter.



Electric Motor in a Bank Note Printing House.

A corporation which has a public duty to discharge is bound not to part with or encumber its franchises.

Consolidations of corporations can be effected when authorized by statute, and must be accomplished in accordance with the direction of the statute.

The courts hold corporations strictly under the control of the state in the management of their business, unless by the elements of contract in their charters they are released in a measure from such accountability.

Certainly there is no law which compels the people to submit to spoliation on the part of corporate bodies which the people acting in their law-making capacity have brought into existence.

ELECTRIC MOTORS FOR PRINTING BANK NOTES.

It is well known to printers that the highest class work in engraving and printing requires a power which is at once steady, reliable and under prompt control. The presses must run with perfect regularity, and at constant speed, and to supply these conditions electric motor power stands unrivaled. Sprague electric motors, from their ability to keep the speed constant under varying loads, have long been used for these classes of work where such sort of service is a desideratum.

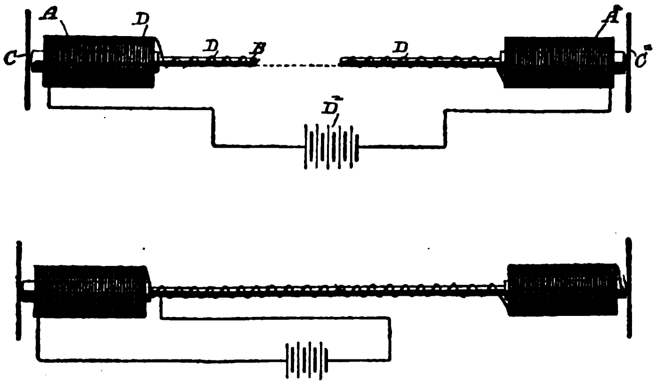
In this issue we illustrate the press rooms of the Boston Bank Note and Lithograph Company, in which all the power used is supplied by a 10 h. p. electric motor. This is belted directly to the line of shafting extending the length of the room, from which are run the presses, folders, cutters, and other machinery used. Only a part of the presses used is shown in the view, the shafting extending a considerable distance beyond the limits of the engraving.

It is interesting to note in this installation the relatively small size of the electric motor compared with the amount of machinery kept in motion. A steam engine of this power would require from ten to fifteen times as much space, without counting the room required for boiler, etc. The motor occupies a space of less than eighteen cubic feet. There are now about twenty Sprague motors used in the city of Boston for operating presses alone, while the total number is in the neighborhood of two hundred.

VOGEL'S METHOD OF TELEPHONIC TRANSMISSION.

THERE has recently been brought out in Chicago a system of telephonic transmission invented by Mr. William Vogel, which embodies a new application of the line wire to effect an increase in the efficiency of transmission. This is accomplished by maintaining the iron or steel conductor in a magnetic state, by which the effect of the vibrating armature of the transmitting telephone is propagated magnetically as well as electrically. The accompanying engraving, Fig. 1, shows one method devised to carry out the idea, in which a soft iron wire, B, has a conductor, D, wound spirally around it, and connected with a battery, D′, so as to form poles at the extremity of the wire. Each pole piece and diaphragm serves either as transmitter and receiver, the transmissions being effected by the change in the magnetic condition set up in the iron wire, B.

The diagram, Fig. 2, shows another method of carrying out the idea, one in which the iron wire constituting the magnetic circuit is also made part of the electric circuit. This has been carried out practically in an apparatus illustrated in Fig. 3, and in enlarged view in Fig. 4. Here the pole-pieces, P P′, are connected by a core wire.



FIGS. 1 AND 2.—VOGEL'S TELEPHONE SYSTEM.

R R is an electric conductor connected with the battery, *r*, and wrapped about the core-wire and pole-pieces, P P′. The extreme end of the pole-pieces of the conductor, R, is wound in a manner to form a thick coil or bundle of wires, R′, and the ends of the conductor are connected with the pole-pieces, as indicated at *r*′. S S′ are electric conductors which surround the pole-pieces, and which are in circuit with local batteries, *s s*′. The current flowing through the conductors, S S′, serves to re-enforce or strengthen the poles of the magnet.

INVESTIGATION OF STANLEY ALTERNATE CURRENT ARC DYNAMO.

THE graduating thesis of Messrs. Tobey and Walbridge[1] embodies an experimental investigation of the new Stanley alternate current arc machine. The general method was to obtain instantaneous values of electromotive force and current at a sufficient number of points to indicate by curves the performance of the machine at every part of a revolution. For this purpose a condenser was charged by a suitable commutating device to the potential it was desired to measure, and then discharged through a ballistic galvanometer. Readings of arc and field current were taken by fall of potential method.

The E. M. F. curve exhibited a very peculiar form, approximating more nearly to a rectangle than to a sine curve. The reversal of direction was very abrupt, the E. M. F. at a load of 20 lamps changing during 3.8° from 960 volts positive to 1,560 negative, making a total of 2,520 volts. This effect is due to the action of the arc, for when the machine worked on non-inductive resistance (incandescent lamps), the curve of E. M. F. approximated quite closely to a sine curve. The arc current in all cases approximated to a sine curve, and the field current exhibited a wiry form, the maxima of this and the arc current curves corresponding.

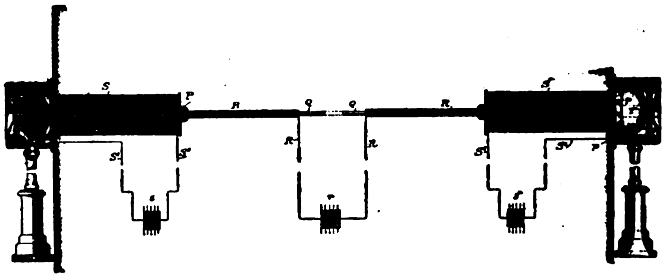


FIG. 3.—VOGEL'S TELEPHONE SYSTEM.

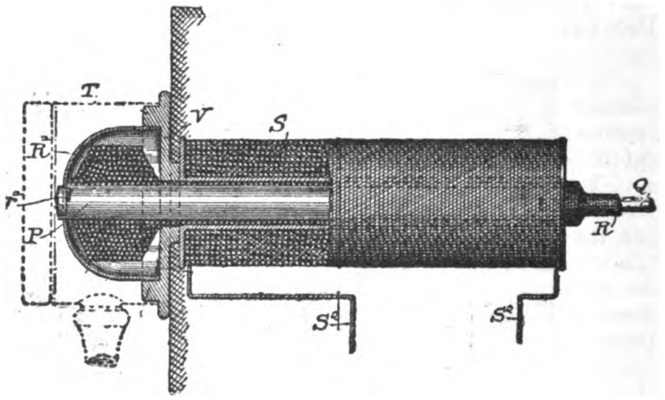


FIG. 4.—VOGEL'S TELEPHONE SYSTEM.

The current lag in all cases was very small, increasing slightly as the load increased. The zeros of both E. M. F. and current moved backward slowly with reference to the pole pieces, as the load became greater.

Owing to the non-arrival of part of the lamps the test has not as yet been completed, but for all runs yet taken for over half load, the machine showed an efficiency of over 90%.

THE EFFECT OF ELECTRICITY ON THE COEFFICIENT OF FRICTION.[1]

BY M. LEVY.

ON account of the variance of opinion of the several experimenters in this line of investigation, the writer has applied himself to obtaining such data as will definitely answer questions directly connected with this subject.

The apparatus used in these experiments consisted in main of an iron plate resting in a perfectly horizontal position on the periphery of three cast iron wheels, the latter restricted to turning except in one direction. If not prevented the plate would therefore take up the same direction and rate of motion as the point at the periphery of the wheel in contact with the plate. This tendency of the plate to move, caused solely by the friction between the wheel and plate, is measured by suitable apparatus provided therefor. Proper measurements were taken when currents varying from zero to 47 amperes passed between the surface of contact of the wheels and plate.

With perfectly clean and dry surfaces of contact and about 45 amperes passing therethrough, an increase in the coefficient of friction amounting to about 119% was observed.

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[1] Sibley Coll., Cornell Univ.

[1] Abstract of Graduating Thesis, Sibley Coll., Cornell Univ.

When the surfaces of contact were bathed in oil 40 amperes increased the coefficient of friction by almost 103%. With a thin coating of oil 47 amperes increased the coefficient 133%. Up to 41 amperes water seemed to prevent the above observed effect of the current.

A current of 40 amperes through the surface of contact of wheels and plate corresponds to a current-density of no less than 5000 amperes per square inch.

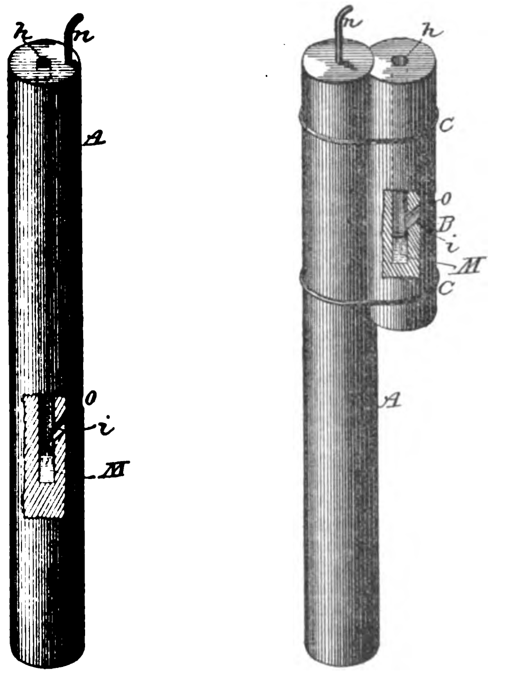
The above are among the most important results obtained in these experiments.

WILLIAMS' SELF-AMALGAMATING ZINC.

The usual method of amalgamating battery-zincs is by immersing them in a suitable acid mixture to clean their surfaces, and then spreading mercury over the surfaces which have been cleaned by the action of the acid mixture. The film of mercury on the zincs gradually disappears during the action of the cells and must be renewed by re-amalgamating or by keeping a quantity of mercury in contact with the zincs, usually in the bottom of the cells in which the zincs stand.

To avoid the trouble of frequent re-amalgamation, Dr. James B. Williams, of this city, has recently designed and patented a zinc which is self-amalgamating, and which is accomplished without removing the zincs from the cells.

The accompanying illustrations give a clear idea of the method employed by Dr. Williams as applied in the case of the plain cylindrical zinc, or in the shape of an attachment secured to the same. The cavity containing mercury M is formed entirely in the substance of the zinc, or in a body B having any suitable shape and size, which can be securely fastened to the zinc by wires C C, which are protected from the action of the battery solution by covering them with suitable compositions. From near the bottom of the cavity a canal *i* runs obliquely in an upward direction, and its opening *o* is on a portion of the surface of the zinc which is below the level of the battery solution. Another canal *h* runs in an upward direction and terminates on a portion of the surface of the zinc which is outside the battery solution. The purpose of the canal *i* is to allow the battery solution to have access to the mercury in the bottom of the cavity, and that of the canal *h* to allow mercury to be poured into the cavity without removing the zinc from its cell. The cavity and its outlets are formed in the zinc during the process of casting or by drilling.

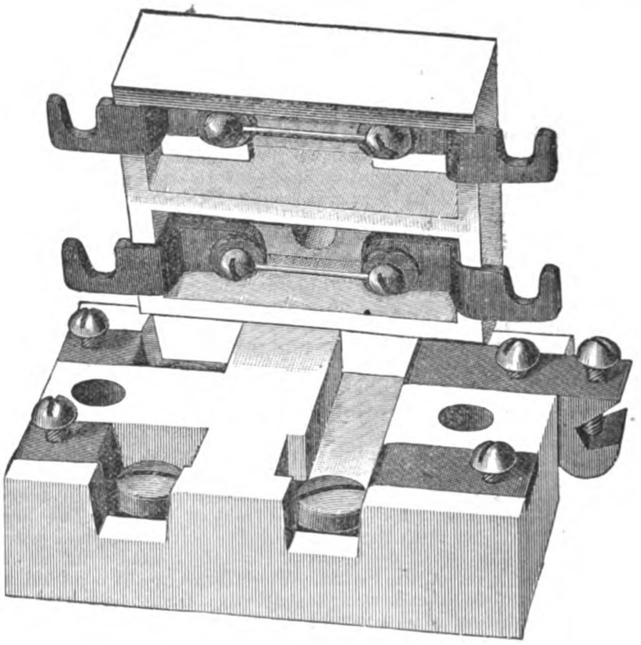


Figs. 1 and 2.—Williams' Self-Amalgamating Zinc.

To prepare the zincs for use, they are first amalgamated in the usual manner, a quantity of mercury placed in the cavities, and the zincs placed in their cells. If the zinc bodies are used, they are first fastened to their zincs and amalgamated with them in the usual manner, and a quantity of mercury placed in their cavities, after which they are placed in their cells. The mercury is renewed from time to time, as the film of mercury on the zincs is removed during the action of the battery. The zincs continue to be self-amalgamating until the zinc is dissolved to such an extent that the cavity will no longer retain the mercury which is poured through the canal *h*.

AN IMPROVEMENT IN DOUBLE POLE CUT-OUTS.

In the handsome new catalogue of electrical appliances recently issued by the E. P. Gleason Mfg. Co., we find illustrated a new design of porcelain double pole cut-outs. This cut-out, as shown in the accompanying illustration, differs from those heretofore employed, in that the fuses are carried by an adjustable cover. By means of this arrangement they can be readily inspected and removed when necessary without disturbing any of the circuit wires. The fuses, it will be seen, are connected to two pairs of lugs which pass under corresponding screws on the base; thus the act of screwing down the lid automatically makes the proper connection. These cut-outs are made in a variety of sizes and designs, and are of excellent construction.



Improvement in Double Pole Cut-Outs.

POSTAL TELEGRAPHS.

The House Committee on Post Office and Post Roads adopted a resolution last week offered by Representative Blount of Georgia, providing that the consideration of the Postal Telegraph bill now before the committee be postponed until the next session of Congress. The resolution also gives the sub-committee having charge of the subject authority to notify all parties interested that any written statements they may desire to present on the matter should be submitted to the committee within the next thirty days.

THE ELECTRICAL EXHIBITS AT THE PARIS EXPOSITION.

BY CARL HERING.[1]

PRIMARY BATTERIES.

BICHROMATE OF POTASH CELLS AND THEIR MODIFICATIONS.

(Concluded.)

M. Gustave Trouvé (French section. Gold medal) had an elaborate exhibit of primary batteries, chiefly for medical purposes and small lights and powers. They are almost all of the ordinary carbon, zinc and bichromate type, and leave little to be described. The small portable and pocket cells for medical and surgical purposes, and for small lights, are arranged in convenient form, as regards plunging of the plates and prevention of spilling the acids. A small portable lamp battery has loose ribs around it like those of an umbrella, which ordinarily are not noticeable, but if the cells should start to fall over, these ribs spread out and prevent it from falling. M. Trouvé exhibited also a small boat run by an ordinary plunge battery. Apparently the only novelty is that the motor and propeller are on the rudder and are geared together by a chain gearing.

M. Trouvé uses a more concentrated solution than usual; his proportions (by weight) are: 1 part bichromate of potash, 8 parts water and 3.6 parts sulphuric acid. The constants of the cells for the boat are: 1.9 volt, .07 to .08 ohm internal resistance; 4 cells will develop 14 kilogrammetres per second for two hours running before it falls.

Most of the batteries exhibited using bichromate of potash for depolarizer, have the zinc in a porous cup in dilute sulphuric acid. Among the principal modifications were the following:

M. Crosse (French section. Honorable mention) replaces the usual carbon plate by a sort of cage of thin sheet lead, perforated, and filled with fragments of retort carbon. The lead acts merely as a receptacle and a conductor for the carbon. The lead cage is made of two concentric cylinders united at the top and bottom, the annular space between them being filled with the carbon fragments. A lead terminal leads off the current. He claims as the advantages, that it is not fragile like carbon plates; it is cheaper; it offers great surface of carbon, lowering the resistance, diminishing the polarization and thereby increasing the rate of discharge; it overcomes the objection to the unreliable brass terminal secured to the carbon plate. A one pint cell costing 50 cts. is said to have a capacity of 30 ampere hours, at a rate of from 1 to 5 amperes. A one gallon cell costing $3.00 has a capacity of 250 to 300 ampere hours at a rate of 6 to 20 amperes.

Overflow Tube.—The following simple and ingenious overflow tube was used in a number of different batteries of this class. The liquid, in such cells, after it has performed its function, is heavier and sinks to the bottom. In adding new liquid to the old, the overflow of the old liquid should be from the bottom of the cell. This is effected by means of a vertical glass tube outside of the cell, the upper end of which tube is bent around in a semicircle forming a nozzle for the liquid to flow out of. The lower end communicates with the inside of the cell through a hole in the bottom. The top curved part of the tube must be just as high as the normal level of the liquid. When fresh liquid is added, the old will therefore overflow automatically from the bottom. If this tube is connected by a flexible rubber tube the cell can readily be emptied by bending down this tube.

Mr. G. U. Lagarde (French section. Bronze medal) exhibited a battery for lighting purposes in which the carbons were revolved continually by an electric motor to agitate the liquid. The cells were arranged in a circle; the fresh liquid was supplied from a tank in and over the middle, the supply cock being opened electrically when the potential had fallen sufficiently. The zincs are perforated. The following data is given by the maker: Price of liquid, 4 cts. per quart; one quart will run a 5 candle-power lamp for 1 hour. The price of the zinc, 40 cts.; the set of twelve zincs will run 240 ampere hours; a battery of 12 cells gives 15 to 18 volts and 8 to 10 amperes, and costs $100.

In the battery of M. Pillet (French section), instead of raising and lowering the zincs, the liquid is lowered and raised respectively, by air pressure produced by a rubber bulb simultaneously on all the cells.

In the medical battery of Chardin (French section) this same principle is used to great advantage, making a clean, practically sealed, cell, very well adapted for physicians and surgeons. The retaining cell is of porcelain and consists of two parts; the upper one, containing the electrodes, is empty when not in use. The lower one is closed completely and contains the liquid. A tube communicates from the lower part of the upper to the lower part of the lower cell. By pumping air into the lower one, which is readily done by means of a rubber bulb, the liquid is forced up through this tube into the upper cell; by allowing this air to escape, the upper cell is drained.

In the Bazin battery for lighting, the carbon plates are in the form of circular disks mounted on a common shaft which is revolved by a small electric motor; the revolving of the plates is claimed to diminish the polarization. In the curves of discharge exhibited, the difference of potential of 1 volt for currents of 9 to 10 amperes is shown to be remarkably constant for 40 to 50 hours' continuous discharge.

In the battery of Kornfeld (Russian section) the cells are very narrow, deep, rectangular boxes made of carbon plates cemented in some way at the edges, and heavily copper-plated on the outside. The box forms the positive pole; the zinc plate is lowered down into the box when in use, and is very close to the carbon on all sides, thus making the internal resistance very low. Liquid is supplied continually at the top and is led out at the bottom in the usual way. The whole battery is very compact.

In the Chameroy (French section) battery, the cell itself is of a tube of carbon, the zinc being a concentric rod secured at the top and bottom. The liquid enters continually at the top and is led out at the bottom. The zinc rod is cast in the form of a screw with a very coarse, deep thread, whereby the liquid is made to circulate in passing down.

In the cell of Radiguet (French section. Silver medal), the object is not only to lift the zinc out of its solution in the porous cup, when not in use, but also to empty this porous cup at the same time, to prevent diffusion of the liquids. To do this, there are two cups at right angles to each other, joined at their open end like the letter L inverted, and turning on a horizontal axis through this point, and over one edge of the jar. One is porous and swings in and out of the jar, and the other is glazed and is outside. The zinc is placed in the porous one. To immerse the zinc, its porous cup is turned vertically so as to be in the jar, and the liquid from the glazed cup flows into it. To withdraw the zinc, the two cups are rotated through a right angle which empties one into the other. In another cell of the same exhibitor, instead of using a zinc plate for the negative pole, he uses a copper tray or basket well amalgamated, filled with scraps of zinc and some mercury. The copper tray acts merely as a conductor, and is not attached, if well amalgamated. The object is to use up scrap zinc.

In the Delaurier cell exhibited by Guérot (French section. Honorable mention), designed chiefly for electroplating, and consisting of zinc, carbon and porous cup, the liquid used with the carbon is made of 87 parts ferro-chromic salt, 198 pts. warm water, and 155 pts. sulphuric acid. The liquid for the zinc is water with a little of this added. The zinc need not be amalgamated. The chief advantage is cheapness.

Residues.—Among other exhibits properly belonging here was an interesting one of Mr. George Fournier (French section. Bronze medal), which may prove of importance in cheapening bichromate batteries by finding a market for the residues of these batteries. The exhibit comprised the various commercial products obtained from these residues. His process of separating the residue into commercial products is briefly as follows: The residue coming from the batteries is a mixture of sulphate of chromium, sulphate of zinc, sulphate of potassium or sodium, sulphuric acid, chromic acid and water. The first process is to neutralize the free acid by means of scraps of metallic zinc This is finished when the solution has become green instead of brown. During this process chrome alum crystallizes out, forming one of the commercial products, being used chiefly as a mordant. The oxide of chromium is then separated by precipitation at 212° F., by adding fragments of zinc, or by oxide of zinc at ordinary temperatures. This is finished when the solution has become quite clear. This oxide of chromium is the second commercial product. The remaining solution is treated with chalk which precipitates zinc oxide together with sulphate of calcium. This is finished when the liquid does not become turbid when ammonia is added. The remaining liquid contains only sulphate of potassium or sodium, or both, depending upon whether the bichromate of potassium or sodium was used in the battery. If only one of these was used, this liquid, evaporated to dryness, forms the third commercial product. To the mixture of oxide of zinc and sulphate of calcium, some sulphate of zinc is added until the solution is slightly acid in order to be sure that no chalk remains; bichromate of potash is then added, forming a bright yellow precipitate of chromate of zinc, which is an excellent pigment, and may be used for coloring paper, for paints, etc., having a great covering power owing to the sulphate of calcium mixed with it. From the chromium oxide are then made different colors, mordants, chromic acid, metallic chromium, and it may be used in the iron and steel industries.

OTHER BATTERIES FOR LARGE OUTPUT.

One of the most interesting of the battery exhibits was the Lalande & Chaperon cell exhibited by de Branville & Cie. (French section. Gold medal for collective exhibit.) It has gradually come into extended use, its numerous advantages giving it a very important place among batteries. It is a single fluid cell with a solid depolarizing substance. It can be used for open circuits, for closed circuits and for strong currents. The electrodes are amalgamated zinc and black oxide of copper; the liquid is caustic potash of 30 to 40 parts to the 100. The action is to dissolve the zinc and to reduce the copper oxide to metallic copper.

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[1] Advance sheets of the report of the expert of the U. S. Commission to the Paris Exposition, Section "Electricity."

Erratum. On page 374, first column, sixth line from top, 56 cts. should read 56 *cent.*

Construction.—One of the principal forms, called the spiral form, is shown in the accompanying engraving, Fig. 3, in which D is the zinc spiral, and A is a thin sheet iron box containing the copper oxide B and a copper wire conductor C, insulated where it passes near the zinc. The cell is 7¼" high and 4¼" in diameter. Another form called the hermetic type, consists of a cast iron bottle forming the retaining cell and at the same time one pole, having the oxide of copper on the bottom. The zinc, suspended by an amalgamated brass rod, is held by the rubber stopper, which at the same time seals the cell. In the large hermetic type the zinc is in the form of a large flat spiral presenting great surface, and the cast iron bottle is closed by means of three bolts and a rubber gasket. In the trough form for heavy currents, the iron cell is in the form of a very shallow flat rectangular box; the layer of oxide of copper on the bottom is covered with a sheet of parchment paper, and the zinc is a flat sheet with a brass lug attached to it. The liquid is covered with a layer of some thick oil. When a number of these cells are to be used in series, as for incandescent lights, they may conveniently be placed one over the other. The size and style of cell depend on the purpose for which it is to be used; the large trough form (about 16" x 8" x 4") is designed chiefly for lighting, small powers, electrolysis, etc.

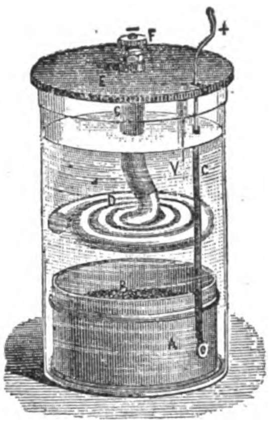

FIG. 3.

Constants.—The following constants of these cells may doubtless be relied upon as correct. The electromotive force on open circuit is from .8 to .9 volt. The following table gives some of the constants for continuous discharge, through an external resistance equal to the internal, that is, for maximum work, in which case, therefore, the difference of potential, or useful electromotive force is slightly less than half of that on open circuit.

	Internal resistance.	Amperes.	Capacity in ampere hours.
Spiral form	0.15	1.5–2.0	70
Hermetic form, small	0.15	0.5–0.7	15
" " medium	0.10	1.5–2.0	70
" " large	0.035	6. –8.	540
Trough form, small	0.10	3. –4.	235
" " large	0.35	6. –8.	540

See also the constants in the expert's reports given below.

Properties and Uses.—There being no great polarization, the cells can be used on closed circuits without any stirring or circulation of the liquid; the difference of potential on closed circuit is said to fall slightly at first and then to remain nearly constant until the materials are almost consumed. The quantity of zinc consumed is very nearly that required by theory, showing that there is almost no local action and that it is therefore not necessary to raise the zinc out of the liquid when not in use. It is therefore well adapted for lighting on a small scale, for telegraphy, electrolysis, etc. The formation of the solution of zinc does not appear to lower its resistance, while the reduction of the oxide of copper to metallic copper diminishes the internal resistance. In using them for lighting or purposes requiring much energy, they are used at, or near, the point of maximum output, which is when the external and internal resistances are about equal. But under these conditions the useful potential is also reduced to about a half, that is, to .4 to .5 volt per cell. Thus, for incandescent lighting it is necessary to have about twice as many cells as the pressure in volts at the lamps. A battery of the large trough cells is said to run two lamps in derivation, presumably 12 to 15 volt lamps. A precaution is necessary in running lamps; as the initial E. M. F. is about double the normal, it is necessary to switch a resistance in series with the lamps at the moment of starting, in order to save the lamps from the strain of the high initial E. M. F. at starting. For charging accumulators, 4 cells must be used for one accumulator. For medical purposes it may be used for a surgical lamp or cautery. On account of its great current capacity it is especially well adapted for signal work or similar purposes, in which strong momentary currents are required.

As there is no local action consuming the zinc when not in use, it is very well adapted for open circuit work, especially when the intermittent current required is comparatively great. It is largely used for microphones and has been adopted by the Société Générale des Téléphones at their central stations. Notwithstanding the low E. M. F., one cell is said to be able to replace a Leclanché, probably owing to its low resistance and the fact that it does not polarize. The latter property adapts it very well for telephonic transmission of operatic, theatrical and musical entertainments, requiring long, uninterrupted service. In such service one of these cells is replacing 5 Leclanchés.

The cell gives off no odors, forms no creeping salts as in the Leclanché, requires no adding of water, or other attention. The solution of zinc formed is very soluble and no crystals attach themselves to the zinc, which therefore requires no cleaning or scraping. The attention and cleaning required by the ordinary Daniell cells used in the large telegraph central stations is by no means a small matter; in London, for instance, there are 27,000 Daniell cells, requiring three miles of shelving.

Regeneration.—After the oxide of copper has been reduced by the action of the cell it can be rendered active again by exposing it to the air for several weeks or by roasting it at a red heat on an iron plate. The cell can also be regenerated by passing a current through it in the opposite direction.

Capacity.—For the same weight the cell is said to have five times the capacity in ampere hours, as compared to accumulators. But such a comparison is misleading, as current cannot be used without potential, and as the useful difference of potential is between one-half and one-quarter that of an accumulator, a true practical comparison should include both, in other words, should be a comparison of energy and not of ampere hours. For the same weight, the useful energy may perhaps be 1½ or even 2 times as great.

Precautions and Objections.—The principal precautions to be taken are that the liquid does not come into free contact with the air, as that changes it into carbonate, and care must be taken not to get the liquid on the hands or clothes. The former is overcome by hermetically sealing the cells, or covering the liquid with a layer of oil. The latter objection is overcome by supplying the salt in an iron box from which it is poured directly into the cell, and water poured over it, so that no handling of the liquid is required. Another objection was that the zinc was rapidly eaten off just at the surface of the liquid. This has been overcome by fastening the zinc on an amalgamated brass rod or strip, so that the zinc is wholly immersed; there appears to be no local action if the brass is well amalgamated.

The prices are from $1 for the small one to $4 for the large trough cell. The zinc, oxide of copper, and the potash for a recharge cost, each, about $1.

These cells have been adopted by the Société Générale des Téléphones, by the Administration des Postes et des Télégraphes, and are used among others in the London Post and Telegraph department.

Tests.—The following extracts are taken from various reports: M. E. Hospitalier discharged the small form illustrated above, through .8 ohm, obtaining about half an ampere for six days' continuous running, or 259,000 coulombs (about 70 ampere hours). The theoretical capacity of the 88 grains of zinc consumed is 260,000 coulombs, showing an almost entire absence of local action. For full report see *l'Electricien*, Aug. 1, 1883. Dr. d'Arsonval obtained 25 amperes from this one, and 106 from the large one, on short circuit. He found that by increasing the temperature from 20° C. (67° F.) to 50° C. (122° F.) the current increased from 4 to 12 amperes regularly with the temperature, and as the E. M. F. remained the same it was due to diminution of the internal resistance. He also finds that there is no local action. See *La Lumière Electrique*, Aug. 25, 1883. In the *Electrician* (London) Jan. 25, 1884, Sir William Thomson gives some results which he obtained. In *La Nature*, Dec. 1, 1883, M. Hospitalier gives some results of running a small light.

CELLS OF LECLANCHÉ TYPE.

The chief exhibit of cells of this class was that of LECLANCHÉ & CIE. (French Section. Gold medal), the original makers of the famous Leclanché cells.

Original Cells.—These cells were usually made of a porous cup containing a plate of carbon and filled with broken fragments of carbon and peroxide of manganese (the mineral pyrolusite of commerce); the negative pole is a zinc rod, and the liquid is chloride of ammonia, the sal-ammoniac of commerce. The zinc is amalgamated and the solution should be a saturated one.

Modification.—The improvement made some time ago, and already well known, and fast replacing the porous cup pattern, was to make hard, conglomerate blocks of the peroxide of manganese with the carbon, which blocks are held to the carbon plate by rubber bands; this replaced the porous cup and its loose contents. The resistance and polarization are thereby diminished, and consequently the useful difference of potential and current is increased. These conglomerate masses are made of broken pieces of retort carbon, peroxide of manganese and shellac, under hydraulic pressure.

Recent Improvements.--The more recent improvements exhibited were the following: The conglomerate mass is made in the form of a hollow cylinder having a metallic terminal fastened to the top, as seen in the accompanying illustration, Fig. 4. The zinc rod, having a tinned wire terminal at the top, and a small rubber cap at the bottom, is placed in the inside of this cylinder and is held concentrically by the cap shown. This increases the depolarizing power of the peroxide of manganese, it being a more rational disposition of that material; the resistance is diminished still more, and the distribution of the current and consumption of the zinc is more symmetrical; the volume and weight are also diminished by this construction; the unreliable rubber bands are dispensed with. This construction enables the price to be diminished 25 per cent. The constants of this cell are, E. M. F., 1.5 volt; internal resistance (a few days after being set up), .4 ohm; weight of positive pole, 1¼ lbs.; price of cell complete, 73 cts.

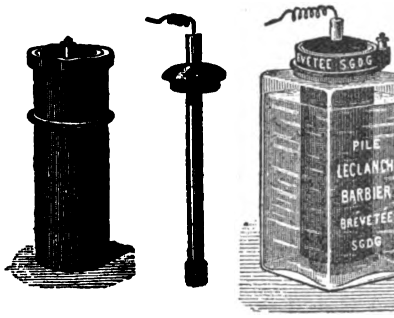

FIG. 4.

New Salt.—Another one of their novelties is a new salt, to be used in place of the sal-ammoniac. The latter has the very objectionable feature that crystals deposit on the zinc, which thereby becomes insulated and is rendered inactive, and which causes the zinc rod to be eaten through, or "cut off" at the top of the liquid, long before it is consumed below. The positive pole also becomes clogged with these crystals. The new salt, which is said to be a mixture of 75 per cent. of ammonium chloride and 25 per cent. of chloride of zinc, obviates the formation of these adhesive crystals and thereby keeps the zinc perfectly clean, enabling it to be consumed evenly and completely. It sells for 26 cts. a pound.

Dry Cell.—Another of their improvements for which they claim a great future is their so-called "dry cell," a poorly chosen name, as the action of all such cells depends on their property of keeping *moist;* a better name would be humid, or moist cells. It consists of a cylindrical vessel of zinc which forms the retaining cell and the negative pole; in this is a conglomerate cylinder similar to the one described above. Between the two is a mass of plaster of paris, moistened with a solution of their new salt; the top is closed with wax. It is sold ready for use. It has the great advantage of requiring no setting up or cleaning and is particularly applicable in cases where the cells are jolted about, as on trains, boats, etc. Its capacity appears to be almost the same as that of the usual cells; see Fig. 5. It sells for 87 cts.

The diagram, Fig. 5, gives a series of discharges made of different cells, showing some of their qualities. The discharges were continuous, through an external resistance of 10 ohms.

After 30 days' continuous discharge, the dry cell still gave 50 milliamperes; the discharge of the ordinary porous cup cell fell to this current in about 15 days. The replaceable conglomerate blocks are of such a size that they are consumed in the same time that one zinc is consumed.

Minor Improvements.—Some of the minor improvements are as follows: In the porous cup cells the porous cups have slits cut into them to increase their porosity. A "cavalry battery" to be used on horseback in military service is made of small carbon plates having a zinc plate cemented to it on one side with a paste of boiled oil and plumbago, making an electrical and mechanical contact; these are piled one over the other with sheets of blotting paper between them; the whole is strapped together without any retaining cell. To render it active, the whole is dipped into the solution, long enough to merely wet the blotters. All the cells are evidently connected in series by this construction.

Instructions.—The instructions regarding their cells are, that the zinc should be amalgamated, the solution completely saturated, that new solution should be added when the old becomes milky, that the addition of chloride of zinc solution is advantageous, and that tinned wire is preferable for connecting the cells.

Other Exhibits of Leclanché Cells.—Among the minor improvements of the Leclanché type of cells as exhibited by different exhibitors are the following: HENRI SERRIN (French section. Honorable mention) exhibited retaining cells made of a single block of wood, lined on the inside with a waterproof coating. Two or more holes may be made in the same block, making a battery of cells complete in itself. He claims cheapness, strength and lightness, and, being sealed, there can be no creeping of the salts, and the cells are as convenient as the "dry cells." He claims that the blocks cost only 0.8 cent each, to make. A complete battery of two cells in one block sells for 39 cents. He furthermore makes his contact to the carbon with a tinned zinc strip, so as to avoid the oxidation of the usual brass terminal.

J. WARNON (French section. Bronze medal) exhibited a new form of terminal to the carbon plate. He claims that in the usual construction, local electrolytic action forms a salt between the metal terminal and the carbon, destroying the contact. In his terminal the brass binding post is tipped on its inside end with platinum, which is pressed against the carbon, by being the end of a screw which passes through the cast lead cap of the carbon. He replaces the porous cup by a coarse linen canvas bag soaked in turpentine and resin, enclosing the active material and tied around the carbon. He claims for this, cheapness and rapidity of discharge. For instance, a half gallon cell with 4 carbons and selling for $1.16, gave 40 amperes on short circuit. He claims that he can regenerate the peroxide of manganese of old cells, so that it can be used over again. This is probably done by charging the cells in reverse direction. He also exhibits some small portable medical cells, 1x1x2¼ inches, selling for only 19.3 cts. each.

THE WESTERN ELECTRIC CO. (United States section. Gold medal for collective exhibit) exhibited Leclanché cells with the porous cups replaced by cotton bags; also porous cups with slots, and canvas around them; also porous cups with holes near the top to replace the usual glass tubes through the top; also glazed cells with numerous holes and a canvas bag on the inside, to replace the porous cup.

CH. R. GOODWIN (French section) makes a large cylinder of the conglomerate mass, having secured to it a zinc rod, forming together one piece. This, he claims, will give 2 to 2¼ amperes on short circuit.

MESSRS. RENAULT & DESVERNAY (French section. Honorable mention) show a "dry cell" in which the moist mass is a siliceous gelatine.

OTHER BATTERIES FOR SMALL CURRENTS.

Among other cells for small currents not of the Leclanché type are the following:

CHAS. CHARDIN (French section. Silver medal), one of the principal makers of electro-medical apparatus, exhibited some very conveniently arranged medical cells which he claims are almost half the weight for the same capacity, and which do not require the cleaning and attention of other cells; an important item for a physician. While the first cost is greater, the cost of maintenance is more than correspondingly cheaper. The cells consist of a high, narrow, cylindrical retaining cell, having a carbon and a zinc rod fastened on the cover which is common to all the cells of a battery. The liquid is bisulphate of mercury, filling about one-third of the cell; on this floats a large cork which fits the retaining cell loosely. In the state of repose the electrodes are separated from the liquid by this floating cork, which also serves to almost seal the cell so as to prevent slopping. By depressing the electrodes this cork is forced down, and in doing so forces the liquid up to electrodes, thus putting the battery into action. As it is necessary to raise the electrodes out of the liquid when not in use, the box containing all these cells is so arranged that the lid cannot be closed until the electrodes have been raised, which is done by a counterweight or spring. The top of the box

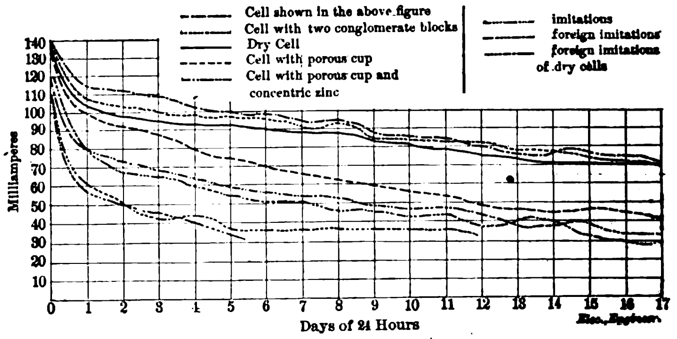

FIG. 5

contains all the ordinary accessory apparatus used for medical purposes. The E. M. F. is 1.526 volt.

The cell of **Dr. Fontaine-Atgier**, exhibited by **Mors** (French section), was also intended for medical purposes. The electrodes are zinc and copper, the latter having a mixture of peroxide of manganese and coke secured around it by means of a sack of thick, ordinary pasteboard. The liquid is potassium hydrate (the soapmaker's potash of commerce); the E. M. F. is 1.49 volt. The advantages claimed are that it can be used on open circuit work; it is quite constant and the resistance is low. A battery of a large number of cells is constructed without retaining cells, as follows: All the electrodes as above described are fastened in pairs connected in series, on a common lid, the zincs being tied against the pasteboard. To put it into action the whole is dipped for a moment into a large tank containing the liquid, and is then withdrawn. Enough liquid rests in the pasteboard to actuate the battery. The whole is arranged to be convenient for transportation.

M. L. **Maiche** (French section. Bronze medal) exhibited a battery in which the depolarization is effected by the air. The negative electrode consists of scraps of zinc in a bath of mercury; the positive is made of a receptacle in the upper part of the jar containing fragments of crushed coke which have been coated with a very thin layer of platinum black; this coke rests half in and half out of the liquid, allowing the air to be absorbed by the platinum black. It is claimed that one of these cells has been in action more than 10 years without any attention. He also exhibited a salt to be used in place of sal-ammoniac which he says will dissolve eight times the quantity of zinc as compared with sal-ammoniac.

Chemically Pure Zinc.—It is in place here to mention the exhibit of **Louis Cahaigne** (French section. Bronze medal), who exhibited chemically pure zinc produced by a new process by means of which it can be made cheaply. It is well known that local action in the zinc used in batteries is caused by the impurities in the zinc; if therefore the zinc is free from other metals it will not be attacked on open circuit, and will not need to be amalgamated, which is a source of trouble and entails no small expense. The process of this exhibitor enables him to make chemically pure zinc at a sufficiently low price to enable it to be employed in batteries. It can be made for 1 franc per kilogramme, or 8.8 cts. per pound, which is very low. Numerous reports from chemical experts are given, showing this metal to be really chemically pure.

Another process of obtaining pure zinc was exhibited by M. L. **Letrange**, but as this is an electrolytic process its description is given under that heading.

Miscellaneous.—**Messrs. Perreur-Lloyd & Fils**, exhibited a battery in which the *residue* of the action was sulphate of copper. But as the electricity generated was a mere by-product, the object being to manufacture sulphate of copper, the description is given under the heading of galvanoplastics.

Mr. Thomas A. Edison exhibited a "chalk" battery, but as the action is probably thermic, it is described under that heading.

References.—For other generators of electricity, see respective headings. For battery carbons, see "Carbons." For substitution of dynamos for batteries on telegraph lines, see "Telegraphy."

EXTENSIVE ELECTRIC RAILWAY PROJECTS FOR WHEELING, W. VA.

In addition to the millions of dollars now being invested in Wheeling, W. Va., by the Eastern capitalists interested in the construction of the great railroad enterprises embraced in the plans of the Wheeling Bridge and Terminal Railway Company, Pittsburg and local capitalists have formulated enterprises for the development of the city and its practical consolidation with the thriving manufacturing towns on the Ohio bank of the river which will call for the expenditure of about $1,000,000. The ideas of these people embrace the construction of three highway bridges across the Ohio, the building of a large electric power and lighting plant, and the construction of about eight miles of electric railroad, extending to the Ohio towns the ten miles of electric railway now in operation in the city.

Two corporations, working jointly, and composed for the most part of the same stockholders, are engaged in the prosecution of this work. One is the Wheeling Bridge Company, with a capital of $500,000, and the other the Bridgeport Bridge Company, with a capital of $300,000. The first-named company has already contracted for two bridges at a cost of $552,000, and work is in active progress upon them. The first will connect the main portion of the city with Wheeling Island, and the second the island with the towns of Martin's Ferry and Ætnaville on the Ohio side.

A double-track electric railroad will run over the bridges and will afford rapid and easy communication with the city. The Bridgeport Bridge Company will erect a bridge from the island to the mainland on the Ohio side, giving like facilities to the people of Kirkwood and Bridgeport. An electric railway line will also cross this bridge and will extend five miles into Belmont County, Ohio, along the old National Road, through a dense population. This bridge, the electric road, power house, etc., will cost about $350,000.

In addition there is projected an electric road from the suburban town of Benwood, the present southern terminus of the existing electric road, twelve miles south to Moundsville, the county seat of Marshall County, and stock is being rapidly subscribed in the East.

The Wheeling and Elm Grove Suburban Road has been extended to Elm Grove, five miles, and laid with sixty-pound rails. The effect of these improvements will be to consolidate a population of nearly 100,000.

PROGRESS IN ELECTRIC WELDING.

In process of construction at the gun factory in Watervliet is a 10-inch gun which, when completed, will be one of the greatest calibre and most wonderful in its design ever made in this country. The huge gun will be built according to Captain Crozier's latest design of wirewinding. Captain Crozier is located in the ordinance department at Washington, and the present gun is the fourth of its kind in existence. The work of boring the gun has been completed, and Thursday next it will be placed in the lathe preparatory to commencing the wire winding. The square wire to be used will be of steel, as is also the gun proper, a tenth of an inch in thickness and will be wound from the breech to the muzzle, the entire length. To produce the desired work a dynamo has been placed in the gun factory which will be utilized to weld the ends of the wire by electricity.

The great demand for artificial ice machines, and the necessity for furnishing long coils of pipe to be used in their construction, has furnished a new and extensive field for the pipe welding machines of the Thomson Electric Welding Company. The difficulty of welding pipe by the old methods is that, unless the joints are perfect, there is an escape of ammonia vapor which renders them practically useless. It is found that by the electric welding process these joints are perfect, and lengths of 400 or 500 feet of homogeneous pipe can be made without difficulty. The electric welds stand bending either hot or cold, and by this process it also becomes practicable to frequently test the coils as they are being bent, and so correct any defects as the process of pipe bending goes on. It is also found that by the electric welding machines the pipe can be brought to any degree of heat that is necessary, and special bends made without the introduction of U joints or couplings, as heretofore has been the practice. Long lengths of pipe, with joints which can be relied upon, can thus be laid in the streets of the various cities for conveying cold from the refrigeration apparatus to consumers. Great demands are being made upon the company from various quarters for apparatus for these purposes. The works of the welding company, at Lynn, are crowded to the utmost to supply machines on orders received.

Roebling's Sons & Co., of Trenton, N. J., have made contracts with the welding company for seven additional machines, to be run from a central dynamo for welding copper wire. This is in addition to the plant which they already had in constant operation day and night since December, 1888. Contracts have been made with the United States Government for a complete welding plant for boiler tubes, bars, rods, etc., for the New York Navy Yard, and also a similar plant to be applied to ship construction at the Norfolk Yard. Several plants are in successful operation in carriage and wagon works in the West, and other plants for the purpose will soon be installed. There are many new developments of the electric welding process which will soon be made public. The welding machine for shell shrapnel and other projectiles is now completed, and arrangements will soon be made by the company for producing these in large quantities.

PHOTOGRAPHING UNDERGROUND.

The use of electricity enabled a photograph to be taken recently under most exceptional and difficult conditions. A landslide occurred at a quarry in France, and a large number of workmen were buried in the subterranean gallery. It was supposed that the men were entombed in one of the galleries about 220 feet below the mouth of the mine; but nothing certain was known of their position, and for an attempt at rescue to have any chance of success an approximate idea of their whereabouts had to be gained. The difficulty was surmounted by sinking a shaft about a foot in diameter, in the direction of the gallery, and through it lowering, by means of a chain, a small camera, mounted in a metallic tube. The camera was pivoted within the tube at its upper end, so that it might be fixed at any angle by tightening or slackening the connecting cord. Above and below the camera were placed rows of incandescent lamps, and when the apparatus had been lowered, the camera was made to incline outward from the case. In order to photograph the interior of the gallery all that was necessary was to turn on the current and light the incandescent lamps, the plate being exposed at the same time. In this manner excellent results were obtained from a photographic point of view, the time of exposure being five minutes.

MEETING OF THE ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

The Ninth Annual meeting of this Association was held at Niagara Falls, N. Y., on June 18 and 19. The following members were present:

C. A. Darlton, president, Washington, D. C.; P. W. Drew, secretary, Chicago, Ill.; C. W. Hammond, St. Louis, Mo.; C. Selden, Baltimore, Md.; A. R. Swift, Chicago, Ill.; G. L. Lang, Boston, Mass.; G. C. Kinsman, Decatur, Ill.; G. T. Williams, Cleveland, O.; M. B. Leonard, Richmond, Va.; R. Stewart, Elizabeth, N. J.; A. Ramseur, Atlanta, Ga.; I. T. Dyer, St. Joseph, Mo.; U. J. Fry, Milwaukee, Wis.; H. C. Reed, Milwaukee, Wis.; J. B. Stewart, Weehawken, N. J.; M. Magiff, St. Albans, Vt.; W. J. Holmes, New York, N. Y.; W. W. Nichols, Chicago, Ill.; W. F. Taylor, Altoona, Pa.; O. C. Greene, St. Paul, Minn.; W. E. Lewis, Long Island City, N. Y.; H. C. Sprague, Kansas City, Mo.; G. M. Dugan, Jackson, Tenn.; L. B. Foley, New York, N. Y.; C. S. Jones, Chicago, Ill.; A. R. Singafelt, Topeka, Kan.; E. A. Smith, Boston, Mass.; S. K. Bullard, Sedalia, Mo.; T. W. Stacey, Marshall, Tex. Many ladies were also present.

The first session of the meeting was called to order by President Darlton, on Wednesday, at 10 A. M. After the reading of the annual report, the following new members were elected:

J. C. Ford, St. Paul, Minn.; W. J. Stonebromer, Two Harbors, Minn.; H. D. Milton, Texarkana, Tex.; J. V. Goode, Kansas City, Mo.; P. H. Hough, La Crosse, Wis.; G. N. Gish, Marshallton, Ia.; H. B. Briggs, Redwing, Minn.; T. W. Parks, Tyler, Tex.; J. N. Miller, Dallas, Tex.; W. D. Hendrickson, Long Branch, N. J.; B. R. Pollock (the world's champion sender), Hartford, Ct.; and L. Horton, Jr., St. Paul, Minn.

The following officers were elected for the ensuing year:

George T. Williams, of Cleveland, O., president; George M. Dugan, Jackson, Tenn., vice-president; P. W. Drew, of Chicago, Ill., secretary and treasurer, was re-elected. M. B. Leonard, Charles Tilden and G. C. Kinsman were appointed a committee on time and place of next meeting.

As the attractions of Niagara are available only by daylight, it was decided to devote the afternoon to a tour along the American and Canadian shores of the Falls and rapids, and substitute an evening session for that usually held in the afternoon.

The first paper of the evening, of which the following is an abstract, was read by Robt. Stewart, Supt. of the Central Railroad of New Jersey, on the "History and Development of the Block System." Mr. Stewart was the first railroad telegraph superintendent to introduce this system of signalling in America. He was at the time connected with the Camden and Amboy Railroad, over which nearly all the Eastern troops passed during the war. A rear collision, which occurred at Bristol, Pa., in the summer of 1863, causing the death of a large number of soldiers and the fireman of the engine, led to the investigation of an English block system, at the request of Ashbel Welch, then president of the company, and Mr. Stewart was instructed to experiment with and put in use a signal, by which trains could be notified, without being stopped on the track, that the next point was clear. After some experimenting, he placed in operation seven block stations upon the 25 miles of road, between Trenton and Kensington, using the banner signal, in conjunction with the regular telegraph offices. There were two fixed glasses, the upper two white, and the lower red, with two independent lamps, one for east and one for west bound trains, which were operated by hand, with a rope attachment. This arrangement proved defective, and a single lamp, with a movable red flannel shield, was substituted. A record of the trains was kept on a board with pegs. The telegraph operators used the regular Morse system for notifying adjacent stations that trains were in or out of the block.

The experiment proved so successful, that it was extended from Trenton to New Brunswick, covering 26 additional miles of road in 1864. Shortly after, upon the formation by consolidation by the United Railroads of New Jersey, the system was extended to Jersey City, making it complete from Philadelphia to Jersey City, excepting between the cities of Newark and Jersey City. In 1870 a connecting road from Frankford Junction to Mantua was equipped, making a total distance of 90 miles. From the establishment of this system up to the date when the road was leased by the Pennsylvania R. R., no rear collisions of any kind occurred, which he attributed to the fact that only the "positive" block was used, in contradistinction to the "permissive" block, afterwards introduced by the Pennsylvania R. R., by which two trains were permitted upon a block at the same time, by observing caution.

In 1873 the Pennsylvania R. R., began the introduction of the system to a limited extent on the Pittsburg division of the main line. Its extension was very slow until the winter of 1875–6, when it was rapidly extended over the entire main line. Its use was stimulated by the approaching centennial exhibition, and in spite of the enormous increase of traffic, the protection was so complete that no accident occurred which could be attributed to its failure.

As originally introduced, the blocks were of considerable length, depending upon local conditions; but on the main line the distance varied from six to ten miles. The signal now used is the standard semaphore. The Pennsylvania R. R., has now a continuous block system from Jersey City to Pittsburg, and from Philadelphia to Washington, the most extensive in this country, and also on the Northern Central division. The officers pronounce it a great success, and an absolute necessity to the road.

On the Central R. R. of New Jersey the electric pneumatic block signal system of the Union Switch and Signal Company, was put into operation in April, 1890, between Jersey City and the Newark Bay draw, a distance of eight miles. The blocks ranging from 1,000 to 1,800 feet are operated on four tracks. At the commencement of each block, signal posts are erected, one for each track, carrying two semaphores. When the upper semaphore is at right angles, it indicates that a train is on the next block. When it projects in this way, the lower one is also set at "danger" or "caution." As the train leaves the block thus protected, the upper signal falls, but the lower remains at caution until the next block is passed and the train is two blocks distant.

These semaphores are operated by pneumatic pressure, controlled by electricity. Those on one block are insulated from the preceding and following blocks. At the end of the block first touched by a train, the right and left hand rails are connected by a wire placed in circuit with two cells of gravity battery. At the other end of the block the same rails are connected through an ordinary relay. When no train is on the block a current passes through this rail circuit holding the armature of the relay in contact, forming a circuit for the local battery. When a train enters upon the track its wheels and axles short circuit the battery, releasing the armature of the relay and breaking the local circuit, having a battery of 8 cells. The local battery operating the semaphore magnet, when its circuit is closed forces open a valve which admits compressed air into the semaphore cylinder and the piston is driven down, forcing the samaphore into the "safety' position. With the entry of a train upon a block, the relay being thrown out of action, the local circuit is opened and the semaphore is drawn by a weight into the "danger" position. Where the "home" and "distant" signals are both operated under these conditions, the arrangement of circuits is more complicated. The supply of compressed air is furnished by a plant of compressors communicating by pipes with a series of reservoirs placed along the line at the foot of the signal poles, and pipes are connected from there to the semaphore signals. The ordinary ties are found to afford sufficient insulation for the rails, but the fish-plate joints not being of ample conductivity are re-inforced by iron wire connections. Between the blocks the rail ends are insulated.

Mr. Stewart then described the various systems of block signals which had been actually introduced, beginning with the Hall system, which was first used on the Eastern railroads in 1871, and has since been greatly improved. Other systems referred to were the Sykes, used on the New York, New Haven and Hartford Railroad, and the Black mechanical signal, the latter being used on the elevated railroads in New York and Brooklyn. Another form of automatic signals used in this country is known as the Union Switch and Signal Co.'s Block System, which has been introduced on the Boston and Albany, Old Colony, New York, Providence and Boston, and a number of other roads. In 1882 it was adopted on the New York and New England Railroad.

The Chicago, Milwaukee and St. Paul Railway Co. has a block system in operation on 146 miles of their Chicago and Council Bluffs division, using a double arm semaphore placed in a position to be seen from both directions. It is operated by hand in connection with an ordinary Morse telegraph.

The Cable Electrical Signal is being experimented with on the Staten Island Rapid Transit Road.

The Chesapeake and Ohio Railroad use a system similar to that of the Pennsylvania Railroad, covering all tunnels and trains going down both sides of the Allegheny mountains, using the Hudson semaphore signal.

The Chicago, Burlington & Quincy Railroad have practically three different systems in use, all non-automatic, the difference being mainly in the manner of connection between offices. The main line from Chicago to Pacific Junction, 482 miles, is now operated under what may be called the "permissive" block. The New York Central Railroad has begun the introduction of a pneumatic-electric system on that part of its track between Woodlawn Junction and the Harlem River, the same as that used on the Central Railroad of New Jersey. The New York Central is also equipping fifteen miles of track near Poughkeepsie with the Hall system. The New York, Lake Erie and Western Railroad uses a block system on 232 miles. Other railroads using various block systems, are the Boston and Maine; Philadelphia, Wilmington and Baltimore; the Missouri Pacific; the Canadian Pacific and the Lake Shore Railroads.

A signaling system operating a visible and audible signal in the cab has recently been introduced by the Desart Electric Co., of Columbus, Ohio. It is used on the suburban road north of the Harlem River. Another electric block system is owned by the Pennsylvania Steel Co.

In closing his explanatory paper, Mr. Stewart said that the system of blocking trains has been, and could be, improved, and that the time is not far distant when upon all the main trunk lines of the country the business will have grown to such an extent that in order to move all trains at a higher rate of speed, especially freights, it will be necessary to locate signal towers at such distances as will permit the use of the "absolute" block to govern all their movements. Speed and safety were so closely allied in the successful operation of railroads that whatever tends to their accomplishment the progress of the times would not permit to be ignored. If a simple and inexpensive automatic system could be devised for operation between the main block stations, a long step in advance would be taken. "Permissive" signaling might then be used with absolute safety at the main stations, as the auxiliary would act as an "absolute" intermediate block.

Mr. Charles Selden read a paper upon the increased adhesion between the wheels of a locomotive and the track, caused by the passage of electricity based upon the experiments and patents of Elias E. Ries, of which the following is an abstract:

From competent authorities on motive power, it has been determined that a locomotive, having a weight of 100,000 pounds, has a tractive power upon the rail, when in best condition, of but 25,000 pounds. And when the rail, by reason of the weather, is in a bad condition, the tractive power amounts to only about what an engine of 15,000 pounds weight should have. In other words, on good rail, by non-adhesion, the locomotive gives but twenty-five per cent., and, on bad rail, but eighteen per cent. of the power which, theoretically, should be had from it.

Efforts were made some fifteen years ago by an Englishman named Werderman, to overcome the non-adhesion, by winding the spokes of the driving wheels with wire, thus making a magnet of the wheel, with the view of attracting the wheel to the rail by magnetism, thus increasing the friction, and, thereby, the adhesion to the rail on the part of the locomotive. Having but a primary battery, it is plainly to be seen that the results were so slight as not to be appreciable. Another objection, even had the dynamo been used, was that, in order to secure sufficient magnetism to be of benefit upon such an immense machine as a locomotive, the magnets would have to be very large, and the winding upon the spokes of the drivers would have necessitated a change in the construction of the engine, so that as the bobbin was being revolved by the wheels there would be room to clear the firebox on the inside and the side-rods of the locomotive on the outside. This, of course, would render necessary a longer crank pin for the bars, and, being longer, it must necessarily be stouter in order to stand the increased leverage, so that a device of this character for the locomotive engine would not be economical, and would necessitate the reconstruction of all locomotives using it. This inventor filed patents in this country and several others followed in his foot-steps, but nothing practical has yet been evolved from that method.

Recently Mr. Elias E. Ries, an American inventor, secured letters patent upon his method of increasing the adhesion of the locomotive to the rail, by the use of electricity, and he took a wide departure from the path pursued by former inventors. Mr. Ries proceeded upon the hypothesis, that an electric current of large volume, if properly employed, could be used to weld metals. Acting upon this theory, he proposes to arrange upon a locomotive, a dynamo of sufficient power, to be run by a small auxilliary engine, and to pass the current from the dynamo to the driving wheel of the engine, along the rail to the next driving wheel, through its axle and the other wheel to the other rail and back to the first driver, thence to the dynamo; thus making a local circuit, so to speak, which would travel with the locomotive, passing a current through the drivers and along the rail as indicated; and for this purpose, by a very simple method, he insulates one pair of the driving wheels. By this means the inventor proposes to cause an incipient weld between the driving wheels and the rails. I say incipient because the wheels, being in motion, the weld, if any, is being made and broken by the revolution of the wheels; therefore, a perfect weld is not obtained; nor, of course, would it be desirable except for brake purposes, as in descending a grade for instance.

If the theory advanced by Mr. Ries can be made a success, practically, it means a great many things to the railroad world. If, by means of this invention, the tractive power of a locomotive is increased, say even twenty-five per cent., it means ten additional cars on a forty-car train. It means a large gain in the hauling capacity on high grade railroads; it means increased speed for passenger trains; it means a saving, indirectly, of fuel; it means the employment of lighter locomotives to do the same amount of work as the heavier ones, thus being easier on the road-bed and bridges, and the mounting of grades that would not be considered possible at the present time. All this, provided, that in practice, on a locomotive, the theories advanced shall hold good.

Another feature of this invention is that it is not necessary to keep the current flowing all the time unless you need it, but when you stop the train and want to start it, your locomotive at that time not being in motion, a more perfect weld is obtained, thus enabling you to start at once without slipping, and after you have gotten your train under headway, your current, if desired, may be switched off; so much for the pulling power and so much for the motor.

The statements made by Mr. Selden were questioned by Mr. Nichols, and a model motor and track were introduced to prove the assertions claimed by the inventor. The experiments made were entirely satisfactory and convincing to the most skeptical—the only question being as to the practicability and economy of the application on a large scale.

Mr. W. F. Taylor followed with a paper on "Lighting at Wrecks." After referring to the importance of powerful artificial lights to facilitate the clearing away of wrecks at night, Mr. Taylor gave a description of the electric light car used upon the Pennsylvania Railroad.

The car itself was an ordinary box car, having an end door with a small extended platform and windows, A 15 h. p. boiler is at one end, surrounded with water tanks of 800 gals. capacity. Near this is a coal box holding two days' supply of fuel. At the opposite end of the car is a 15 h. p. Westinghouse engine, making 300 revolutions per minute. Near the centre of the car is a 10-light Weston dynamo making 1,000 revolutions per minute. Suitable receptacles are provided for tools, lamps, etc. On one side of the car two reels of wire are permanently fastened, one of which contains a wire that is run out as a feed wire, the other being connected to the last lamp of the circuit and is used as a return wire. The lead wires are connected with a brush which connects with the axles of these reels, thus giving a path for the current. Upon the top of the car are carried tripods and tools for hanging the lamps. The car is manned by a crew of one engineer and four linemen. In starting for a wreck the regular crew is always preferred, as they are thoroughly drilled. Arriving upon the ground the first thing is to locate the car; then determine the number and location of the lamps. Then a man is started out with the end of the wire from the small reel, followed by another carrying pole, spike and hammer, or tripod, as required; then the third man with the lamps and a short section of wire; continuing till the last lamp is reached, when the wire on the larger reel is run out and connected with the last lamp, thus completing the circuit. The lamps are swung from the most available points, portable poles being used if necessary. These are usually made of 4″ x 4″ hickory, 18 feet long with the lamp. At the bottom a piece of 1″ gas pipe is clamped to the pole. To erect the pole a steel bar is driven into the ground, and the pole is then lifted up so that the gas pipe will go over the steel bar. In the bracket at the top of the pole is a pulley through which a rope passes and thus draws up the lamps. The pole is more easily handled than a tripod.

The time occupied in starting up the lights is shown in the following instances: Wreck No. 1, 7 lamps, ⅜ mile of wire, started in 1 hour; No. 3, 7 lamps, ¼ mile wire, 1¼ hours; No. 4, 6 lamps, ½ mile wire, 35 minutes. The cost of equipping a car ready for service was about $2,500. In operation it costs about $1 per lamp per hour, but even if it cost $5 per hour it would be worth it.

Mr. Taylor gave descriptions also of the Lucigen and the Wells lamp, both of which used petroleum. The Wells light is now being used by the Pennsylvania Railroad, and both styles were in use after the Johnstown flood.

Papers were read by Mr. M. B. Leonard, on "Electric Lighting in Railway Service;" by Geo. C. Kinsman, on "Train Despatching, Its Uses and Abuses;" by Prof. H. S. Pritchett, of Washington University, St. Louis, on "Correct Time, How Shall We Maintain It?" The meeting adjourned Thursday evening to meet next year at Cincinnati.

There was a larger number of exhibits than usual, among them being that of the Hall Signal Company, the Edison Phonoplex System, the Edison-Lalande Battery, the Electric Secret Service Company, the Pennsylvania Steel Company, the Molecular Telephone Company, P. B. Delany, the O'Neill Crossing Signal, and the Desart Electric Company, W. T. Brown, president and general manager, and the Brown Electric Protective Company, of Philadelphia, Pa.

LETTERS TO THE EDITOR.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the serial number of such letter, and of the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

MAGNETISM AND FLUORESCENCE.

[130.] If any of your readers have made or have heard of any investigations as to the action of a powerful magnet on phosphorescence or fluorescence, I will consider it a great favor if they will publish the facts, or communicate with me, in your care.

J. J. J.

New York City.

CORRESPONDENCE.

BOSTON.

Trial Trip of the Tripp Manufacturing Company's New Eight-Wheel Car.—Legislative Investigation of Methods of Securing Elevated Railway Franchises.—Thomson-Houston Dividend.

By invitation of the Tripp Manufacturing Company, a number of gentlemen representing the Tripp Company, the Thomson-Houston Company, the West End Street Railway Company, and other electric railways, were present at the trial trip of their new car on the lines of the West End Company. The car started from the Grove Hall stables at 7.30 P. M., and reached the Tremont House at 8 o'clock, whence it made a trip to Allston and back. The car has already been described in these columns, but a repetition may not be inappropriate at this time. The car, which was built by the Newburyport Car Manufacturing Company, is mounted on double trucks and has eight wheels. It is 28 feet long from door to door, 7 feet, 3 inches wide, 7 feet, 9 inches in height from floor, and has seating capacity for 46 passengers. Each truck has four steel wheels and one 15 h. p. Thomson-Houston motor. The car is provided with vacuum and hand brakes, and the brakes are operated by a toggle joint arrangement, giving immense power. The Tripp anti-friction bearings are used throughout, and the car is hung on trucks of an entirely new design (on which patents are pending), the equalizing bar being connected to the journal boxes underneath, instead of passing around the top as hitherto. The car is also provided with the Jewett frictionless car centres, which carry the weight of the car on frictionless rollers that move with the slightest strain, permitting the car to adjust itself to the movement of the trucks. There are less parts and fewer bolts about the new Tripp truck than on any other form of truck, and they leave plenty of room for the application of the motors and electrical apparatus. The trip was entirely satisfactory, except in rounding some of the sharper curves, where considerable difficulty was experienced owing to the trolley wheel coming off the trolley wire; but a few changes which are contemplated will undoubtedly overcome this difficulty.

The official investigation into the alleged irregularities in the methods of several of the elevated railroad companies to obtain a franchise in the city of Boston, has been thoroughly pushed this week and is still in operation. No decision has, however, as yet been arrived at, and the flood of testimony goes to show that no actual corruption of members of the legislature exists, though large entertainment is fully and freely admitted by the West End and other companies.

The Thomson-Houston Co. has declared a semi-annual dividend of 3½ per cent. on the preferred stock, payable July 1. On the same day dividends will be paid on series C and D securities in amount not yet determined, but contingent upon negotiations for the sale of securities liable to culminate before the payment falls due.

Boston, June 21, 1890.

BALTIMORE.

City Electric Lighting.—New Deals and New Companies.

The all absorbing topic in Baltimore just now is how and by whom the city electric lighting is to be done. The situation is rendered more interesting by the purchase of the Waterhouse and Brush Electric Companies by the Westinghouse Electric Company —this combination being one factor in the fight—and the acquisition by the Fort Wayne Electric Co., of Mr. J. Frank Morrison, so long and well known in electric lighting circles through his connection with the Brush Electric Company, of Baltimore, and his management of the Baxter Electric Motor and Mfg. Co., lately re-organized under a slightly different corporate name.

The Fort Wayne Company has certainly secured an effective champion in Mr. Morrison, as the exciting incidents of the past few weeks have shown. After a brisk struggle, the Baltimore Common Council passed an ordinance, giving the Brush Company authority to light the city of Baltimore for a period of five years at 40 cents per light. At this juncture, Mr. Morrison has succeeded in impressing the mind of the Mayor with the idea that it would be an injustice to the city of Baltimore to bind itself for so long a period at this price when the Fort Wayne Company in the course of four months stand ready thoroughly to equip a plant capable of doing the same work and at 30 cents per light. The Mayor's impression would not be of such vital importance were it not for the fact that incidentally it carries with it a refusal of his signature; so the end is not yet.

The Brush Company contend that their investment should be protected, that the company who risked its all in the establishment of Baltimore's first electric light industry, when electric lighting was in its infancy, should have the co-operation of the city, especially after the faithful performance of its contracts for so many years; while the new company say that the name of Mr. Morrison is sufficient guarantee that they are in earnest, that the city should not shoulder an unnecessary expense, when only a few months will develop an opportunity for retrenchment. At a meeting of the Council Committee before whom the whole matter was discussed a few days ago, some of Mr. Morrison's friends good-naturedly twitted him of playing the part of "Ajax defying the lightning." This was because he appeared single-handed in joint debate before this Committee, with the officers and board of directors of the Brush Company, the company whose manager he had been until recently. In view of the unanimous passage of the ordinance in favor of the Brush Company and against Mr. Morrison and the Fort Wayne interests, it seemed as though the simile was well drawn; but now that the Mayor sturdily refuses to sign the ordinance under any circumstances, it begins to look as though the "Ajax" might come out ahead of the lightning after all. It is claimed by those who are familiar with the situation that if the Brush Company had long ago taken Mr. Morrison's advice and consolidated with the Waterhouse interests, Mr. Morrison would still be at the helm and there would have been no split. However, it remained for the Westinghouse Company to show the shrewdness to make the consolidation by purchasing these companies outright, and at this juncture Mr. Morrison severs his connection with the Brush interests and champions the new cause. The situation is being watched with great interest and the denouement will end for a time one of the most exciting political and corporate contests that Baltimore has seen for many a day. Probably the contest never will be really ended, as in such a political cauldron as is Baltimore, it will always be impossible for any effervescing reaction to precipitate the salt of indifference.

Baltimore, Md., June 21, 1890.

PITTSBURG.

Motors in Mining Work.—New Works of the Standard Underground Cable Co.—The Allegheny City Plant.

The Hercules Mining Machine is rapidly coming into general use in the coal district of the Monongahela Valley. Owing to the fact that the miners are getting scarce here, coal operators hail with great satisfaction this new electric mining machine. At the Summerhill mines, near Woodville station, five of the machines have now been in use for several months, and they have been a thorough success there from the very start. The Hercules Mining Machine is operated by the Tesla alternate current motor of the Westinghouse Electric Company. The motor and the system have given such good satisfaction that Messrs. Armstrong & Co., the owners of these mines, are now putting an alternate current electric light plant in the mines. Since the introduction of the Hercules mining machines in the Summerhill mines, each machine has produced on the average for every working day, 48 tons of coal, and if the fact is taken into consideration that it only requires one man to operate the machine, an idea may be had of the great saving. Several of the machines are now being put in the mines of the Monongahela Gas Coal Company.

A manufacturing plant for the production of iron electric light poles has been established here under the name of the Whitmore Mfg. Co. The firm finds the field a comparatively new one and reports a large number of orders ahead.

Another of the Westinghouse industries is about to remove its manufacturing plant from this city into the country. This time it is the Standard Underground Cable Company, for which a large tract of land has been secured at Brinton, on the P. R R., about 12 miles from Pittsburg, and a mile from Wilmerding, the new home of the Westinghouse Air Brake Works. There will be six buildings comprising the entire cable plant, two of them with dimensions of 60 by 276 feet and the remainder 60 by 80 feet. All the buildings will be of brick and stone. A town is also being laid out near the works for the accommodation of the employes. This town will have the peculiarity of having all its streets named by electrical expressions, for instance, there will be Electric avenue, Volt street, Dynamo way, and so on.

On the first of July the Allegheny City electric light plant will commence operations. The power house is now completed and all the wiring of the lines, the putting up of the towers and mast arms has been finished. The plant has a capacity of 3,000 incandescent lamps and 450 arc lights. The Westinghouse alternate current system of incandescent and arc light apparatus are to be used here. The power house is probably one of the most comprehensive structures for its purpose in this country. It is only two stories high and the entire machinery is placed on the ground floor, which affords an easy observation of the entire plant. At the very rear of the building is the boiler room with 6 Erie boilers and a Roney stoker each. The latter is an economic appliance for the use of coal. The engine capacity is composed of seven 100 h. p. compound engines, one 50 h. p. and four 15 h. p. engines of the Westinghouse standard type. These engines are belted to the three 1,000 incandescent dynamos, two exciters and nine 50-light arc machines. The lights are distributed throughout the town by 52 towers and 25 mast arms. The Allegheny people are congratulating themselves upon the prospect of the new light and there is no doubt that the city will be one of the best lighted in the country.

Pittsburg, June 21, 1890.

LITERATURE.

Electric Light Installations and the Management of Accumulators. By Sir DAVID SALOMONS, Bart. London, WHITTAKER & Co.; New York, D. VAN NOSTRAND Co., 1890. 334 pp. Price, $1.50. Second notice.

THIS volume, considerably revised and enlarged, is a fifth edition of the well-known little work on accumulators first published about four years ago. Each edition as it has appeared has been partially rewritten and amplified until the present volume has entirely outgrown the scope of the original work, which consisted mainly of a description of the interesting installation at the author's residence at Broomhill. Already French and German translations of the earlier editions have been published which, with the appearance of a fifth edition so soon, indicates an extensive circulation, partially attributable, no doubt, to the monopoly of the subject matter which the book has so far enjoyed.

The author himself remarks with surprise that up to the present time no other book has been written on the special subject of the management of accumulators, and suggests a very remarkable explanation of the cause. According to Sir David there are only two classes of persons who are interested in the subject, viz., the manufacturers and the users; and as the former cannot be expected to know very much about batteries, their knowledge being confined to laboratory tests, and few of the latter having either the necessary experience or time to write on the subject, the requisite qualifications are only possessed by the few scientific observers who may happen to become users. Very likely some of the men who have devoted their energies to improving accumulators, and who have borne the brunt of introducing them into commercial service, will be inclined to take exception to this very peculiar reasoning.

It is rather remarkable, nevertheless, in view of the many articles that have appeared from time to time in the electrical journals, and the numerous papers read before electrical societies on the subject of accumulators, that no comprehensive treatise embracing the theory, applications and management of accumulators has yet appeared. The works of Reynier and Tamine, published respectively in 1884 and 1885, describe various practical forms of secondary batteries which had been introduced up to that time; the little work of Gladstone and Tribe contains an excellent account of the chemistry of secondary batteries, while the articles and papers referred to have touched upon almost every application of such batteries to the arts; yet, notwithstanding the abundance of material, such a compilation is yet to be forthcoming.

The author of the present volume has not made use of much of the rich matter at hand, but has preferred in the main to confine himself to the records of his personal experience and observations, which, however, have not been inconsiderable. This experience has been gained during several years past in equipping and operating an accumulator plant for lighting the author's private residence. Upwards of $40,000 has been expended in the construction of this installation, of which a considerable part has been sunk in experiments. The work is divided into two main divisions, the first treating of the forms and actions of accumulators, and the second being descriptive of working installations. While the first part is so written as to give the reader a very clear idea of the peculiar nature and actions of a secondary battery and the conditions under which such a battery should be set up and operated, the second portion of the book, on the other hand, is rather too limited and vague in its descriptions of circuit connections, making it somewhat difficult for anyone not previously acquainted with the devices to obtain what may be called "working" knowledge of the systems described.

The several chapters comprising the first division of the volume are devoted respectively to a general description of cells, setting up of cells, charging, discharging and probable causes of failures and their remedies. The batteries described are those manufactured by the Electrical Power Storage Company, and those of the Elwell Parker types, both of which embody the essential features of most commercial accumulators. The construction of these cells, and the general principles governing their actions, with rules for their management during charge and discharge are explained in a simple and practical manner, and much useful information relating to the setting up and manipulation of an accumulator battery is embodied.

The first chapter of the second division indicates the main requirements and some of the more essential minor details for gas, oil and steam engines suitable for driving dynamos for moderate sized lighting plants, and describes many of the more recent improvements which have been made in such engines. Among these may be mentioned a novel boiler feeder and a new automatic drip cock for attachment to engine cylinders. Several forms of English dynamos and motors are illustrated, and the operation and handling of the same explained in a very practical manner. Much information regarding the erection of shafting and the care of machinery generally is also included. In the following chapter various switches and indicating instruments employed in accumulator installations are illustrated and described, as well as various forms of incandescent lamps and fittings and methods of wiring. The prevention of fire risks forms the subject matter of the next chapter in which the rules and regulations issued by the Society of Telegraph Engineers and Electricians are printed in full.

Methods of automatically governing the operation of combination plants, and the actions of secondary cells when worked in conjunction with dynamos are discussed at some length in Chapters IV and V. The behavior of the cells during charge and discharge is explained very clearly, but the great number, and the expensive character of the instruments employed to effect automatic regulation, and the complexity of the system as a whole, give a very erroneous idea of the simpler requirements of an ordinary plant. The author's main potential regulator which is the essential feature of the automatic system described, is, unfortunately, not illustrated, and the description of this instrument is so vague that those unfamiliar with its general design will be likely to obtain an imperfect idea of its character. Although foreign to the scope of the book, the general principles of the alternating current system are next explained, and after brief chapters on testing and estimates, the work is brought to a close by a brief account of the installations at the author's town and country residences.

The book is illustrated by nearly 100 engravings, but it is to be regretted that it does not contain more diagrams which go so far towards explaining clearly the methods of working accumulator installations. On the whole the volume contains a great deal of useful information, and we hope the author may in a subsequent edition find room to cover the whole field of the subject in the manner hinted at above.

REPORTS OF COMPANIES.

MR. VILLARD'S NORTH AMERICAN COMPANY.

The following important circular has been issued to the stockholders of the Oregon & Transcontinental Co. by Mr. Henry Villard, president. It will be seen that the new "North American Company" is to pay its attention to electric light and power :—

The Board of Directors have much pleasure in informing you that they have succeeded in making provision for the payment of the outstanding bonds of the Company. The Northern Pacific Railroad Company having agreed to place at our disposal a sufficient amount of its consolidated 5 per cent. bonds for that purpose, a contract has been entered into with a strong syndicate under which the payment of the bonds under the terms of the mortgage on November 1, 1890, is assured. The syndicate includes Messrs. Drexel, Morgan & Co., J. S. Morgan & Co., of London, Drexel & Co., Speyer & Co., Brown Bros. & Co., Kuhn, Loeb & Co., L. von Hoffman & Co., J. & W. Seligman & Co., Winslow, Lanier & Co., Edward Sweet & Co., Lee, Higginson & Co., John D. Rockefeller, the Deutsche Bank, Berlin, Jacob S. H. Stern, Frankfort-on-the-Main, and L. Speyer-Ellissen, Frankfort-on-the-Main.

The main obstacle to the reorganization of the Company having thus been removed, your Board were enabled to determine the definite course of procedure to that end under the authority vested in them at the meetings of the stockholders of June 17, 1889, and November 5, 1889, and now lay before you the reorganization programme decided upon.

It is proposed to form a new corporation, whose charter will more certainly give us the desired powers than the existing one does. After careful consideration of all the questions involved by ourselves and by counsel, it has been decided to reorganize under the laws of the State of New Jersey, and that the name of the new Company shall be The North American Company.

It was first contemplated to reorganize with a smaller capitalization than the present one, but a very large majority of the stockholders objected to a reduction. With the ascertained consent of fully three-quarters of the stockholders, it is intended to make the authorized capital of the new company the same nominal one as that of your company, viz.: $50,000,000, but of which only $40,000,000, corresponding to the outstanding stock of your company, shall now be issued.

The new company will offer to exchange, share for share, four hundred thousand full-paid shares of its stock of the par of one hundred dollars each, for the outstanding four hundred thousand shares of your stock.

Thirty days will be allowed for effecting the exchange. Your Board will arrange so that stockholders who do not make the exchange shall have their share of the assets of the Company either in kind or in cash at an appraised value. In order to obtain a valuation, the fairness of which no one shall be able to dispute, the Presidents of three of the leading Trust Companies of New York city will be invited to make it. Should a partial sale or distribution of the assets become necessary, the Company will have to be placed in a state of liquidation, which can be done at any time under the direction of the Board of Directors, as authorized by the stockholders at their meetings.

Due public notice will be given of the successive steps in the reorganization, as explained in the foregoing, by this Company, as well as by the new Company.

We do not hesitate to strongly recommend in advance to all stockholders to come into the new Company, for the following reasons:

(1.) There is every ground to believe that the career of the new Company will be a prosperous one from the outset. There will be among its stockholders individuals and firms in this country and Europe of large influence and resources, and it can rely upon the support of strong financial groups here and abroad.

(2.) It is intended that the company shall operate mainly in two special fields. One is that of railroad financiering. As we are certain of the regular custom of several large and prosperous railroad systems, we can confidently look forward to an extensive and profitable business in this connection. The other field will be the promotion of electric light and power enterprises. The substitution of the electric light for other illuminants, and of electric for steam power in manufacturing and transportation, that is now progressing all over the civilized world, and nowhere more rapidly than in this country, offers the greatest opportunities for the lucrative employment of large capital. It is expected that the company will have the closest affiliation, as a stockholder and otherwise, with the Edison General Electric Company and the Thomson-Houston Electric Company, which two powerful corporations do most of the electric lighting and nearly all the business of equipping electric railroads in the United States. The general public have but a limited understanding of the great growth already attained by the industries devoted to the practical application of electricity and the enormous development of which they are capable. But we feel sure that the use of your capital in this direction will bring large returns.

More detailed information regarding the new company will be submitted in its formal invitation to you to become stockholders in it.

THE STATUS OF THE CONSOLIDATED ELECTRIC STORAGE COMPANY.

THE Consolidated Electric Storage Company, of this city, have just issued the following important circular defining their status and their plans as manufacturers of the Julien battery and the exclusive licensees for the United States of C. F. Brush's storage patents:—

We take this means of informing you that this company has been organized for the manufacture and sale throughout the United States of the Julien Storage Battery. To that end, it has acquired those storage battery patents which, in its opinion, control the manufacture and sale of storage batteries for the United States.

In order that you may understand the scope of those patents, we will describe in a few words what constitutes a storage battery as at present universally made.

Gaston Planté, whose storage battery was the first to attract public attention, used the following method. He employed two plates of lead, which he immersed in a solution of sulphuric acid and water; he then applied a current of electricity which had the effect of creating on the surface of the plates, by disintegration of its substance, a spongy substance, known as *active matter* or *absorptive material*, being spongy reduced metallic lead on one plate and peroxide of lead on the opposite plate. This process required several weeks and sometimes months of charging, involving too much labor and expense to make the Planté battery one of commercial value. Radical and fundamental improvements were needed to make the storage battery what it is to-day. To Charles F. Brush, of Cleveland, Ohio, has been awarded, both by the United States Patent Office and the United States Circuit Court,[1] priority of invention of those improvements. Mr. Brush obtained the same technical results as Mr. Planté by applying the active matter to the plates *mechanically* before immersing them in the solution. He also made *receptacles* in the plates and *mechanically* filled those receptacles with lead oxides (active matter) by *pressure*. He then put the plates into the solution and subjected them to a charging current, by means of which he obtained in a few hours the results which Planté reached only in weeks or months of charging. The battery thus made had, moreover, much greater capacity than those of the Planté type. This method has, for obvious reasons, superseded that of Planté, and since Mr. Brush's invention (1879) all commercial storage batteries are made by applying the active matter mechanically to the plates. The plate, wall or support to which the oxides are applied is known as the *support plate* or *conducting support*, and the oxides applied to the conducting support are generally called the *active matter* or *absorptive substance*. The solution in which the conducting support, with the absorptive substance applied thereto, is immersed, and which usually consists of sulphuric acid and water, is called the *conducting liquid* or *electrolyte*. Mr. Brush applied for patents for his inventions. He was put in interference with Camille A. Faure, who made similar claims to invention,[2] and after a long and bitter contest for a period of four years before the patent commissioners, Mr. Brush was awarded priority; and on March 2, 1886, United States Patent No. 337,299 was issued to him. This patent covers broadly the *mechanical application* in any form (whether powder or paste) of the *active matter* or *absorptive substance* to a support plate. This is the decision of the United States Circuit Court in the case referred to. Any method of application by hand or machine is "mechanical." The court also decides that the words "active matter" and "absorptive substance," as used by Mr. Brush, are synonymous, and include not only lead oxides but every other substance that is absorptive (and it must be absorptive to be of any value), applied to a conducting support." It does not matter what shape or size the conducting support may take, whether it be smooth, perforated, woven wire, flat, cylindrical, etc.; so long as it is a "conducting support," it is an infringement of the above patent.

In addition to this broad invention, this patent also covers, expressly and by specific claims, the support coated with mechanically-applied metallic oxide, oxide of lead or equivalent lead compound, and red lead; and also such a support when provided with "receptacles" filled with the mechanically-applied oxide of lead or other "active material."

The word "receptacles" was found by the Court to include perforations extending through the plate.[3]

This patent has nearly thirteen years still to run and is controlled by this company. Another important patent now controlled by this company was sustained by the United States Circuit Court, viz.: Patent No. 266,090, covering a support with "cells," "cavities," "slots" or "perforations," and the words "cells or cavities" were held by the Court to include perforations as well as cavities of other forms.[4]

Patent No. 260,654, also controlled by this company, covers the application of the "absorptive substance" to the "conducting support" by "*pressure*," whether exerted by hand or a machine.

The batteries made by the Gibson Company, The Electrical Accumulator Company, The Pumpelly Company, The Woodworth Company, The McLaughlin Company, The Anglo-American Company, and others, consist, all of them, of a "conducting support" and "absorptive substance" mechanically applied thereto, and are clear infringements of the Brush patents.

This company has also acquired United States Patent of Edmond Julien, No. 347,300, covering an "inoxidizable" "conducting support." Experience has shown that the "conducting support" is so influenced by the electric current as at an early stage to oxidize and become disintegrated. Mr. Julien, who was one of the first inventors and workers in the field of the storage battery, has discovered a certain alloy of lead and other metals, whereby this defect in the plain lead support is overcome. It is regarded as a most valuable invention. The patent has ten years to run.

To guard against imposition by persons who may pretend to have discovered a new battery, we wish to inform the reader that it is universally admitted that so far as scientific research has gone, only the metals and their salts (metallic oxides), may be employed to make a commercially useful storage battery, and only those metals and their salts may be employed which are practically insoluble in the electrolyte. The elements or electrodes of a commercially useful storage battery consist of two parts, first, a "support," and second, an "active" or "absorptive" substance applied and secured to the support. Gold and platinum, but for their costliness, would be the most useful metals to employ for the support, as they are practically inoxidizable in the electrolyte, or exciting fluid or solution of the battery. Of all the cheaper or base metals, lead possesses in the highest degree this immunity from attack by the exciting fluid or solution, and for this reason it has been chiefly employed where a simple metal has been used for the support plate.

The alloy of lead, antimony and mercury patented to Edmond Julien is, however, far superior to lead in this respect, and approaches more nearly than any other metal or alloy, the cost of which would permit its use, to gold and platinum.

Many attempts have been made to use various metallic compounds for the active or absorptive substance to be applied to the supports. These have been applied in various ways, but no commercial success has yet been reached by any experimenter in the use of any substance or by employing any method of application except reduced (or spongy) metallic lead and its oxides, mechanically-applied and secured to the support plate.

Time would be wasted in listening to the pretensions of any inventor who professes to have contrived a commercially useful storage battery the elements of which do not consist of a metallic support practically inoxidizable in the electrolyte or solution, having mechanically applied to or secured thereon either reduced spongy metallic lead or one of the oxides of lead, or equivalent lead compound.

This company has also acquired United States Patents No. 383,757 and 408,986, of Henry G. Morris and Pedro G. Salom. Messrs. Morris & Salom have been engaged, for some years past, in devising suitable machinery for the effective and economical manufacture of storage batteries. These patents cover a machine known as the Mechanical Filler. Prior to the invention of this machine, the active matter was applied to the "conducting support" by hand. The method was laborious and expensive and the work generally uneven and unsatisfactory. The mechanical filler obviates all these difficulties. By its use each machine dispenses with the labor of from thirty to forty men, and fills the plates uniformly and far more effectually than can be done by hand. It is the first and only machine of the kind that has ever, so far as we can learn, been invented or claimed to have been invented, and as it is both novel and highly useful, we deem the validity of the patents unquestioned. These patents have about sixteen years to run. It will be seen from the above that agents and electric companies, in recommending the batteries of this company to their customers, will be freed from the annoyance of litigation.

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[1] Electrical Accumulator Company *vs.* Julien Electric Company, 38 Fed. R., p. 117. Brush Electric Company *vs. id.*, 41 *id.*, p. 679, and decree entered on this decision on June 10, 1890.

[2] Electrical Acc. Company *vs.* Julien Electric Company, 38 Fed. R., at p 130. Brush Electric Co. *vs.* Julien E. Co., 41 Fed. Rep., at p. 686.

[3] See last case at p. 690.

[4] See last case at p. 692.

SOCIETY AND CLUB NOTES.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The following gentlemen were elected to associate membership in the Institute, by the Council, on June 17:—

Cleveland F. Dunderdale, agent Westinghouse Electric Company, 146 Adams street, Chicago, Ill.

Eugene R. Holcomb, electrician, agency Thomson-Houston Electric Company, 234 Montgomery street, San Francisco, Cal.

H. A. Sinclair, electrical engineer, The Tucker Electric Company, 950 Bedford avenue, Brooklyn, N. Y.

F. H. Chamberlain, electrician, Metropolitan Railroad Company, 2411 P street, N. W., Washington, D. C.

George Cutter, dealer in electrical supplies, 192 Fifth avenue, Chicago, Ill.

John S. Cobb, with S. R. Krom, general manager and mining engineer, 151 Cedar street, New York.

J. P. B. Fiske, electrical engineer, Thomson-Houston Electric Company, Lynn, Mass.

H. G. Reist, electrical engineer, Thomson-Houston Electric Company, 113 Franklin street, Lynn, Mass.

James B. Cahoon, electrical engineer, Thomson-Houston Electric Company, 257 Washington street, Lynn, Mass.

Axel Ekstrom, electrician, Thomson-Houston Electric Company, Lynn, Mass.

R. B. Owens, superintendent, Greenwich Gas and Electric Light Company, Greenwich, Conn.

Geo. L. Colgate, electrical engineer, Bedford Electric Company, Bedford City, Va.

George Francis Myers, laboratory of Wm. Stanley, Jr., U. S. Electric Lighting Company, Newark, N. J.

Augustè F. Mason, general manager, Simplex Electric Company, 620 Atlantic avenue, Boston, Mass.

Harvey L. Lufkin, general agent, "C. & C." Electric Motor Company, 404 Greenwich street, New York.

William H. Powell, New Britain, Conn.

M. J. Francisco, president and general manager, Rutland Electric Light Company, Rutland, Vt.

Messrs. A. J. Lawson, C. H. Davis, M. Brooks, D. C. Jackson, F. E. Jackson, T. Stebbins and Dr. L. Bell were transferred to full membership.

The last meeting of the Institute of the season was held on June 17, when papers on alternating current work were read by Prof. H. J. Ryan and Messrs. Powell and Humphreys, all of Cornell University.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

At a meeting of the Executive Committee, held Monday, June 16th, it was decided, as stated by us last week, to convene the Twelfth Convention of the National Electric Light Association at Cape May, New Jersey, on Tuesday, August 19th. Full details of the arrangements made for the Convention will be published at a later date.

Mr. Allen R. Foote entered upon the duties of Secretary and Treasurer of the Association on Tuesday June 17th.

Mr. J. E. Lockwood, chairman of the committee on papers, has issued a circular inviting papers as well as likely names and topics.

THE ORDER OF RAILWAY TELEGRAPHERS.

The Order of Railway Telegraphers, which is credited with a membership of 8,000, has been holding a convention in this city during the past week, some 70 divisions being represented. It was the fifth annual convention of the order. The order is essentially benevolent, and while it seeks to promote the general welfare of its many members. its constitution declares that a forfeiture of membership shall be incurred by any member who shall instigate a strike.

LEGAL NOTES.

THE THOMSON VAPORIZING METER IN THE PATENT OFFICE.—THOMSON vs. TAVENER.

In the interference proceedings between Prof. Elihu Thomson and Tavener relative to the electric meter in which current is measured through the medium of a liquid vaporized by a heated conductor in circuit, the examiner granted the motion of Prof. Thomson's counsel and held that the British patent did not disclose or illustrate an operative device, for which reason he dissolved the interference. It was strenuously contended by counsel for Tavener, at the hearing before the primary examiner, that the defects of the British patent were immaterial, but the examiner held otherwise.

Prof. George Forbes also claims to be the inventor of the method of measuring electricity consisting in vaporizing a liquid by the heating effects of the current and then measuring the amount of vaporization. This is the subject of his patent No. 387,505, August 7, 1888. This invention is claimed by Prof. Thomson as his own, and an interference is now in progress in the Patent Office between the patent of Forbes and an application of Prof. Thomson. The examiner attempted to place the burden of proof upon Thomson in this interference, but upon appeal, the Commissioner by a recent decision shifted the burden of proof from Thomson and placed it upon Forbes, Thomson having been the first to file an application in the Patent Office showing and describing the invention. The counsel for Prof. Forbes have recently made a motion for re-hearing, which will be heard by the Commissioner shortly.

THE SHALLENBERGER METER.—THOMSON vs. SHALLENBERGER.

The Shallenberger patent of November 5, 1889, No. 414,595, for the Shallenberger meter, has been placed by the Patent Office in interference with an application of Prof. Thomson, which was pending in the Patent Office at the same time with the application of Shallenberger. The parties will shortly begin to take their testimony.

PLATINUM.

The demand of the electrical industry for platinum is making that already precious metal more precious. The price, it is announced, has already risen 100 per cent. in value within the last year, and it is expected to continue in its upward course, never, perhaps, to be cheaper. It would be a small fortune to the chemist who could provide a substitute.

INVENTORS' RECORD.

Patents issued June 17, 1890.

Alarms and Signals:—*Combined Fire-Alarm and Gas-Lighting Device*, C. H. Crockett and C. C. Allen, 430,175. *Burglar-Alarm*. S. Broichgans 430,378.

Conductors, Conduits and Insulators:—*Insulator*, S. Oakman, 430,296. *Underground Electric Cable*, W. R. Patterson, 430,297.

Distribution:—*Method of Synchronizing Alternate-Current Machines*, E. W. Rice, Jr., 430,320.

Dynamos and Motors:—*Regulator for Dynamo-Electric Machines*, E. Thomson, 430,327. *Alternate Current Motor*, E. Thomson, 430,328.

Galvanic Battery:—*Voltaic Battery*, T. A. Edison, 430,279.

Lamps and Appurtenances:—*Manufacture of Incandescent Lamps*, W. L. Voelker, 430,156. *Arc Lamp*, A. C. Alcock and H. Galopin, 430,260. *Electro-Magnetic Cut-Out for Electric Lamps*, E. Thomson and E. W. Rice, Jr., 430,326. *Electric-Arc Lamp*, E. Thomson, 430,357. *Incandescent Lamp*, F. C. Rockwell, 430,437 and 430,485.

Measurement:—*Electric Meter*, J. Oulton and J. Edmondson, 430,432. *Electric Meter*, G. H. Wade, 430,551.

Metallurgical:—*Magnetic Separator*, T. A. Edison, 430,275 and 430,280. *Process of Melting or Reducing Metals by Electricity*, T. J. Willson, 430,453.

Miscellaneous:—*Electric Switch*, J. A. Norton, 430,252. *Electric Incrustation Preventative*, W. B. Bull, 430,462. *Vending Apparatus*, J. J. Busenbenz, 430,463. *Electric Crane*, A. J. Shaw, 430,487.

Railways and Appliances:—*Electric Car*, L. Pflugst, 430,147. *Electric Railway*, R. M. Hunter, 430,208 and 430,580. *Signal for Electric Railways*, E. M. Bentley, 430,263. *Electric Railway*, M. J. Wightman, 430,329, *Electric Railway*, D. S. Devore, 430,515.

Telephones and Apparatus:—*Telephone*, J. H. Irwin, 430,128. *Phonogram Blank*, T. A. Edison, 430,274. *Phonograph*, T. A. Edison, 430,276 and 430,278. *Automatic Determining Device for Phonographs*. T. A. Edison, 430,277. *Coin-Controlled Telephone Guard*, S. M. Dowst and F. H. Hosmer, 430,569. *Phonogram Blank*, T. A. Edison, 430,570.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

SOME NEW WESTINGHOUSE INSTALLATIONS.

A few days ago the Westinghouse Electric Company received cable advice from England that it had been awarded the contract for furnishing a complete outfit of its alternate current apparatus for the establishment of a plant in Barnsley, Yorkshire. At a recent meeting of the town councils, that body decided to discontinue the use of gas as an illuminant of the town and substitute the modern method of lighting. The plant is to have a capacity of six thousand 16 c. p. incandescent lamps and one hundred arc lights of the new Westinghouse alternating current arc lighting system. The contract is said to have been obtained in the face of the keenest competition.

The Hamilton Electric Light Company of Hamilton, O., has contracted for a 500 light Westinghouse alternating current incandescent dynamo to its plant.

The electric light company at Newport, R. I., which has heretofore been operating the Edison direct current system of incandescent lighting has closed a contract with the Westinghouse Electric Company for one of its 500 light alternating current dynamos.

The electric light has evidently found favor in Washington state. A company which started in the town of Tacoma less than a year ago, with a 750 light plant, has already been obliged to make arrangements for an increase of its capacity. A contract was awarded the Westinghouse Electric Company for alternating current apparatus of 1500 lights capacity.

The Westinghouse Electric Company has received the contract for the installation of an alternating current dynamo of 750 lights in Saginaw, Mich., where an electric light company was recently organized.

Vinton, Ia., is one of the latest central station plants to be furnished with the Westinghouse alternate current apparatus. This plant will start with a capacity of five hundred 16 c. p. lights.

Hiawatha, Kan., is to have an electric light plant of 500 lights. The Westinghouse system of alternate current incandescent lighting will be operated in the plant.

The Cincinnati Zoological Gardens, a public resort, which has justly became famous the world over, not only on account of the magnificent gardens and the romantic scenery, but also for the valuable collection of animals it contains, is about to be illuminated by electricity. The Westinghouse Electric Company received the contract a few days ago to instal one of its 40 light dynamos of the Westinghouse alternating arc light system within the Zoo.

THE CONSOLIDATED ELECTRIC STORAGE COMPANY.

The important circular issued by this company from its offices, 120 Broadway, is printed elsewhere in this issue. To the New York headquarters all communications as to agencies and licenses should be addressed. All orders and inquiries for batteries should be addressed to the company, 926 Drexel Building, Philadelphia. The Atlantic Trust Co., trustee, representing more than two-thirds of the stock of the Julien Electric Traction Co., offers to the remaining outstanding minority stockholders of the said company the privilege of exchanging their stock, share for share, for Consolidated stock, without payment of assessment or expense. The Consolidated Company has a capital stock of $3,000,000 in shares of $25. It has no bonds and no preferred stock, and as is well known, controls the Brush fundamental storage patents.

MORE ELECTRIC CARS FOR RICHMOND.

The city of Richmond, Va., will always be remembered by street railway men as being a place where the superiority of electricity over other methods as a means for propelling street cars was first demonstrated. Although the apparatus installed at Richmond for street railway work was almost the first which had been designed for operating a street railway of any considerable size, the results, as our readers well know, were such as to call forth the admiration of street railway and electrical engineers, and were the direct precurser of the great impetus in electrical equipment which has since followed.

Experience has taught a great many things, and there have been a large number of changes made in the design of electrical apparatus, but it is interesting to note that Richmond is still enthusiastic over electric traction, and that the two other important roads in the city of Richmond, the Richmond City Railway and the Richmond & Manchester Railway have decided to supplant animal power by electric power.

These contracts, one with the City Railway Company, being for 10 cars, and the Richmond & Manchester Road, being for 5 cars, were closed by the Sprague Electric Railway and Motor Company during the last month.

Those who remember the newspaper stories and attacks on the early work at Richmond, when nothing seemed too bad to say of the apparatus, will be interested in the following report from Mr. David Mason, of June 11:—"The cars are running smoothly here at present, though they are carrying very heavy loads. On the 29th of May, the day of the unveiling of Lee's Statue we carried, with an average of twelve cars on the main line, fourteen thousand and eight hundred and forty-five people who paid fares, and probably two thousand people who did not pay fares, and that with old No. 5 motors. Summer cars would have from one hundred to one hundred and fifty people on at one time. Several conductors collected sixteen fares on the roof of the cars. Every inch of room on the cars was occupied."

THE BAXTER ELECTRIC MOTOR COMPANY.

The following circular has just been issued by the Baxter Electric Motor Co., of Baltimore, Md., to the users of electric power:—

"We take pleasure in informing you that the Baxter Electric Motor Company has been organized and has purchased the extensive shops, valuable machinery, patents and other valuable rights and franchises of the late Baxter Electric Manufacturing and Motor Co. and is supplied with sufficient capital to fully guarantee to every company or individual desiring motors, that from this date, there will be no delay or difficulty in furnishing machines or duplicate parts. We especially desire to call the attention of our patrons to the complete equipment of motors for elevator (passenger and freight), street railway service, mining generators, for complete power plant, always proving themselves economical, durable and reliable, as well as up to the rated power. The superior qualities of the Baxter motor have gained for it a standard reputation in electrical and mechanical efficiency which is beyond all competitors The services of a competent and first-class corps of experts have been obtained, and no expense will be spared to win the patronage of those using or contemplating the use of electrical power. The mechanical devices used in the construction of these motors have lessened the cost of manufacture, and we are thus enabled to defy competition. We invite inquiry and will take pleasure in quoting on our regular line of goods; particularly on special construction."

ISOLATINE.

The well known firm of Roessler & Hasslacher Chemical Co., 73 Pine street, this city, are introducing on this market a new insulating material of remarkable qualities invented by the prominent German chemist, Dr. Kunheim. They say of it: "Dr. Kunheim's Isolatine is the most effective electric insulating material known. It is a bituminous viscous liquid mass unexcelled for the coating of wires and cables, for filling in tubes and boxes wherein electrical conductors are placed, for preparing insulating layers, and, in short, for all purposes of protection to electrical conductors against the escape of electricity. The merits of Isolatine are its withstanding all aerial and subterraneous influences (moisture, changes of temperature, sewer and coal gases and acids) as also its unchangeable toughness. It does not grow brittle or porous but retains its elastic gum-like consistency under all conditions."

The Isolatine comes packed in barrels of about 500 lbs.

THE ELECTRICAL SUPPLY CO., CHICAGO.

This enterprising and successful company has recently secured the services of Mr. Charles Wirt, who has resigned his position as Chief Inspector to the United Edison Manufacturing Co., and has already moved to Chicago to assume his new duties. Mr. Terry has done well to associate so able and conscientious an electrical engineer and worker with him, and the new departure will enhance the reputation of the company for good, solid and progressive work.

SCHIEREN BELTS IN THE UTICA ELECTRIC RAILWAY PLANT.

Chas. A. Schieren & Co. of 45-51 Ferry street, this city, say:—"We have just received a report in regard to the five double 'Electric Perforated' belts which we furnished the Utica Belt Line Railroad Co. at Utica, N. Y., viz., that they are the best belts in the opinion of the superintendent that he ever saw, and we think we can conscientiously claim superiority for our 'Perforated Electric' belts over any unperforated belt for this electric power especially. The 'Perforated' belts will run with less tension than an unperforated belt; they can be run very slack and because of this fact they are well adapted to the uneven strain of an electric railway. Electric power is different from electric light, in respect to the fact that it is uneven, sometimes the full force will be on, and at other times thrown off suddenly, and because of the fact that the belts run slack they will adapt themselves to this uneven change more readily than if belt were kept at a tight tension all the time."

GALLANT WORK OF AN EDDY MOTOR.

An interesting episode in which an Eddy motor played the title role, is thus described by the *Toronto Empire* of May 29 :—

Some consternation was caused in the works of the Barber & Ellis Manufacturing Company, on Bay street, yesterday morning, by the breakdown of the engine. As the break was rather serious it was thought that the fifty or so hands which the firm employ would have to remain idle for three or four days until repairs were made. Luckily, however, an "Eddy" electric motor stationed on the third flat, which has done service for a section of the works on night shifts, was brought into use. The experiment of driving all the machinery on the three flats of the building by this motor occurred to the superintendent, Mr. L. P. Bouvier, and its application was attended with the most successful results. Although the motor at 220 volts, develops only five-horse-power, it did the work equally as well as the seventeen horse-power engine with its cumbersome gearing, and the entire staff continued to work the whole day. The current was got from the Toronto Incandescent Electric Light Works on Terauley street. The only stoppage was that of the elevator, it being feared that this would overtax the little "hummer." An idea of the serious loss that would be sustained by the firm if the works had been stopped may be had when it is said that the turn out of envelopes alone is 900,000 per day. A large number of patent machines are used in the manufacture, and they are attended by girls. The machinery driven by the "Eddy" motor on the three flats yesterday included fifteen envelope machines, three cutting presses, eight glueing machines, two box-covering machines, two scorers, three cutters, one embossing press, one corner cutter and five ruling machines. The connections included 800 feet of shafting. Operations in the building yesterday were so satisfactory that it is likely electricity will be adopted as the motive power in the future.

THE COMPLETE ELECTRIC CONSTRUCTION COMPANY.

On June 11, the fine plant of the Manhattan Electric Light Co. in this city was struck by lightning. The switchboard was burnt out, and no fewer than 32 Ft. Wayne dynamos were disabled. Mr. Leslie, the manager, immediately went to work, however, to meet the emergency. He was able, with the help of other local companies, to supply many of his customers, and with the help of the Complete Electric Construction Co., of 24 Cortlandt street, which put a large gang of its handiest men at his disposal, he was able to get all his circuits going last week and to take care again of 20,000 lights. The work thus effected classes with the quickest on record, and Mr. Leslie is entitled to no little credit for the pluck and promptness with which he faced the disaster. The Complete Electric Construction Company now have over 200 men at work.

THE PITTSBURGH REDUCTION COMPANY'S ALUMINUM.

While it is generally understood in a vague sort of a way that aluminum is some day destined to be the all-pervading metal—that on account of its lightness, ductility, malleability, conductivity, etc., it will find its way universally among the arts, it is not generally known that a real live company is turning out the metal at the rate of a ton a week, which out-put is sold weeks and even months in advance.

The Pittsburgh Reduction Company, of 95 Fifth avenue, Pittsburgh, Pa., have recently issued a pamphlet which is not only comprehensive and well conceived, but at the same time really instructive, and which will repay careful perusal. The processes used by this company are those perfected under the patents of Charles M. Hall, by means of which they are capable of offering aluminum in ingots at the very low rate of $2 per pound in lots of one thousand pounds and over ; $2.25 per pound in lots of 500 pounds and over, and $2.50 per pound in lots of 100 pounds and over. Their price list does not stop here, but goes into the details of prices of sheets, rods, wires, and various forms of the metal, besides giving a general dissertation on its properties and a statement of the different uses to which it is particularly adapted. Throughout the catalogue there are interspersed little tables which are exceedingly interesting. For instance, on page 5 we learn that a cubic foot of cast iron weighs 444 pounds, with a tensile strength per square inch of 16,500 pounds ; while a cubic foot of aluminum weighs only 168 pounds, with a tensile strength of 26,800 pounds per square inch. Then follow tables giving the behavior of aluminum after fracture compared with that of other metals, its elasticity, conductivity, etc. On page 12 is an interesting statement to the effect that the Eureka Tempered Copper Co., of North East, Pa., has succeeded in hardening castings of aluminum in the same way as it hardens copper. The most careful and delicate tests have failed to show the slightest hardness given to aluminum by the process of chilling as practised with cast iron. One of the best features of the pamphlet is that aluminum is not made out to be a *perfect* metal—its bad points are indicated as clearly and dwelt upon as strongly as its good ones—all of which imparts an air of refreshing candor, which should be appreciated by the student of commercial literature. The conductivity of aluminum appears to be about three-fifths of that of pure copper wire at a temperature of 57° F., and about one-half of that of copper at the temperature of 170° F. This makes the conductivity of annealed aluminum wire many times that of iron wire, either plain or galvanized. The Pittsburgh Reduction Company is about to expand in order to take care of its increasing orders, and it is not unlikely that a month or two will see its present output of a ton per week doubled and perhaps quadrupled.

THE GREAT WESTERN ELECTRIC SUPPLY CO.

This company are now getting in excellent shape to handle a large supply business, and are ready to receive and execute with the greatest promptitude the largest orders. They have put in a very large and extensive stock of electric and combination fixtures of the handsomest design and workmanship. Mr. Crolius, an expert in this line will have charge of the fixture department. Their handsome suite of offices are now well advanced, and will be ready for occupancy very shortly. The beautiful antique finish which has been employed throughout their construction makes a remarkably attractive appearance. Mr. Chas. G. Armstrong has been appointed manager and electrician of the house goods department, and no more timely and excellent selection could have been made, and he will be a most valuable addition to Mr. Cutter's staff. Mr. Armstrong was for some time superintendent and electrician for G. A. Harmount, who formerly represented the New Haven Clock Co., and is now known in connection with the Monitor Electric Company. All the electrical work in the famous Auditorium building with the exception of the electric lighting plant, was improvised and installed by Mr. Armstrong, who is well known amongst the electrical fraternity as an electrician of the highest ability. He is also the inventor of a new District Telegraph system which will be handled by the Great Western Electric Supply Co., and numerous other important and novel electrical appliances. Mr. C. A. Robinson, formerly of the Sprague Equipment Co., has also placed his valuable services with the company, and is manager of the Electric Street Railway supply department. With such a staff as this under the able leadership of Mr. George Cutter, naught but an immense success awaits the company.

GAS ENGINES IN ELECTRIC LIGHTING.

President Joseph Barstow, of the Atlantic City, (N. J.) Gas Company, is very much elated, says the *American Gas Light Journal*, over the economy that has resulted in the electric lighting department of the company's business as a consequence of the partial displacement of steam power by gas power in the dynamo room. A 50 horse-power Otto engine has been installed in the works on Michigan avenue, and its operation is pretty close to perfection. The company, which has the contract for the public electric lighting of the city, operates the Thomson-Houston system of full arcs and has over 100 lamps in circuit, with the probability that that number will be doubled by July 15th. By the way, the rate charged for arc lighting on public account is very reasonable—25 cents per lamp per night.

"LOCOMOTIVE TELEPHONES."

The idea of portable telephones is by no means new, but a novel application of it is thus recorded in the Washington *Star* of June 7 : "A test was made this afternoon of the electric railway signal of the Universal Electric Railway Signal Company of Richmond, Va. About three miles of the track on the Baltimore and Ohio has been provided with this signal system by way of experiment. The apparatus consists of an electric circuit formed by a single iron rod, which is laid between the tracks, and a wire brush attached to each engine in connection with an electric gong and telephone. Two engines approaching each other on the same track come into circuit at the distance of one mile and a-half or more, according to strength of the battery, and at once the telephone bells ring. This is a signal for the trains to stop, and the engineers may talk with each other on the telephone to discover the trouble, whatever it may be. Two trains were sent out on the Baltimore and Ohio this afternoon with a party, including several gentlemen from Washington and Virginia and correspondents of newspapers in different parts of the country. The tests were made and proved extremely satisfactory."

ELECTRIC MOTORS FOR THE ERIE CANAL BOATS.

An electrical engineer of Buffalo suggests what seems to be a practical plan in reducing very largely the cost of transportation on the Erie Canal. His plan is to adapt the trolley system now generally in use on street railways to the canal. If the overhead trolley system can be applied to street railways at a cost of about half that of horse power, he argues, why can it not be made to take the place of canal mules with a similar reduction in cost? The poles and other appliances for the overhead wires, and in fact the whole plant, covering the entire length of the canal, could be readily arranged without hindrance to navigation. The span would not be too wide at any point. Power stations could be so located as to operate sections of thirty miles on either side, being sixty miles apart, and at some points water power might be utilized.

The great objection to the propeller system would, of course, be the damage to the canal banks through the action of the wheels, but the promoter of this scheme suggests the use of a twin screw wheel or a wheel working low in the water. A motor of smaller size than that used on street cars would certainly accomplish more than six mules now used in caring for two boats, granting that all else was equal. The electricity might be used to light the canal as well as the boats, and a telegraph system could be arranged on the poles used in supporting the trolley wires. One man aboard any of the boats could handle the trolley, and at the same time care for the rudder. The scheme altogether appears practicable. It would also be feasible to use electric motor tugs for the same class of work.

THE EDISON GENERAL ELECTRIC COMPANY.

The Edison General Electric Company has been taking steps for the closer organization of its business and the consolidation of its manufacturing interests. Mr. Samuel Insull has been elected Second Vice-President and entrusted with the direct supervision of the manufacturing and sales departments, and this change has already gone into effect.

PERRET MOTORS FOR MINING WORK.

The Elektron Manufacturing Company of 79–81 Washington street, Brooklyn, have recently experienced a brisk demand for their motors for mining work. Mr. F. A. Perret, their electrician, has just returned from a flying trip West with an order for seven 15 h. p. motors to be used in the mining of coal, in combination with one of the best undercutting machines in the market. Their low speed multipolar type of motor is meeting with great success, as might be expected, the recommendations of such a machine being numerous and often unequaled.

THE WESTERN POWER CONSTRUCTION COMPANY.

The most recent organization, and the only one in Chicago devoting itself entirely to the construction and equipment of steam plants for electric lighting and power work of all kinds is the Western Power Construction Company incorporated by capitalists in Chicago with a paid up cash capital of $500,000. This powerful organization will make its principal business the construction of power plants throughout the entire west, without reference to any special electric system, it having no connection whatsoever with any particular company, but open for business and work of the highest class to all irrespectively. The success of the company is assured from the start and the limit of its operations is still to be found. Mr. Waldo P. Adams has been appointed general manager of the company, a man of immense ability and wide experience in electrical and steam engineering all over the country. The principal offices are located at 144 Adam street in the Rookery. Mr. J. E. Wilson, formerly of J. A. Grant & Co., Boston, is associated with the new concern and will occupy a prominent position therein.

SIMPLEX ELECTRICAL COMPANY'S NON-INDUCTION WIRE.

The Simplex Electrical Company are developing a large field for their non-induction wire for telephone and signal work, and are receiving some good orders since putting up a few months ago the first demonstrative lines. They are also in receipt of some very warm testimonials, and Mr. R. F. Ramsey, treasurer of the Federal Street and Pleasant Valley Passenger Railway Company, Pittsburg, in a recent letter says in relation to its qualities, as follows:—

"It affords us pleasure to say that we have found the anti-induction telephone wire furnished us by your company for our private telephone lines, all and more than was claimed for it. Our system consists of a central station, comprising 14 telephones, and 10½ miles of wire. The wire is placed upon the same iron cross arms, and iron poles, upon which are placed the feed wires from our power station, through which we operate 20 miles of road, and 50 motor cars. We find the service perfect, and disturbance from induction or other cause, entirely absent."

LATTICED IRON POLES.

The Electric Merchandise Co., 11 Adams St., Chicago, are the agents for the "Latticed Iron Poles" manufactured by the Wisconsin Bridge and Iron Co., which are being so largely introduced for street railway work on account of their numerous advantages. The company is in receipt of the following letter from Mr. A. M. Hinckley, Supt. of the Milwaukee Electric Railway Company:—

"To whom it may interest we would say that the latticed iron poles furnished to us by the Wisconsin Bridge and Iron Co. are giving us the very best of satisfaction. We believe them to be the strongest and best pole ever made for this purpose. They are strong and ornamental in appearance and hold the trolley wire up in the very best of shape. We intend to use this kind of pole in all our future construction. We now have over 500 of the poles in use." Such tokens as these speak very highly for the article. We would call the attention of our readers to the announcement in our advertising columns.

TELEPHONES FOR EXPORT.

Mr. James H. Howard, general manager of the Tropical American Telephone Company, sends us a communication calling attention to a new pamphlet entitled "The Telephonic Rights of the Tropical American Telephone Co., Limited," recommending a careful perusal of it. Mr. Howard claims "that neither the Western Electric Co., nor the American Bell Telephone Company ever had any telephonic rights in South or Central America, the West Indies or Mexico but simply in the United States. For convenience sake and to save expenses of experiments, etc., the Tropical American Telephone Co., buys its telephones and transmitters and patented apparatus of the American Bell Telephone Co., *for export to its countries*, and no one else has any right or authority to export them to these countries without permission of the Tropical American Co., and all export orders should be addressed to it direct."

Mr. Howard also states that "The Tropical American Telephone Company has arranged with the well-known Hannover, Germany, house of J. Berliner, brother of Emile Berliner, the inventor, to sell his improved telephonic instruments in Central and South America. Mr. Williams, who has examined the instruments, pronounces them equal to any he ever made for the American Bell Telephone Company in the United States."

TELEPHONES FOR CUBA.

The Compañia Electrica de Cuba of New York, continues to supply telephones for export to Cuba. This company, organized in 1881, purchased in that year from the owners all patent rights in the Island of Cuba, under the Spanish telephone patents of Bell, Blake and others. They furnish telephones—transmitters and receivers—coming direct from the American Bell Telephone Company.

THE CUTTRISS CALCULATING DISC.

This calculating disc is an improved form of slide rule, by means of which a great variety of mathematical calculations can be performed. The instrument consists of a thin metal disc, round the circumference of which slides a ring of corresponding thickness, both the disc and the ring having scales engraved upon them. Two scales are engraved on the disc, and two on the ring, and by placing the scales in definite relative positions with each other, calculations can be readily performed, involving multiplication, division, proportion, vulgar and decimal fractions, powers, roots, and a large variety of problems. With a little practice and by the aid of simple constants many problems specially useful to electrical engineers may be rapidly worked out. The very portable and simple nature of this calculating disc seems to render it eminently suitable for use in outdoor work.

HUNTINGTON SEARCH LIGHTS ON SOUND STEAMERS.

Some weeks ago we illustrated the Huntington search light. The steamer "Connecticut," of the Providence and Stonington Line, has recently been equipped with one of them. Men have been employed on the big boat for the past few months installing the light and getting it in running order. They accomplished their task only a few days ago, and now the big steamer can forge its way through Long Island Sound during nights when fog dims the eyes of the ever watchful pilot without much fear of collision. The wonder is how Long Island steamers ever managed to do without the search light. The search light is situated on top of the pilot house, and is played on any quarter desired by the pilot within. At his will he can throw the powerful light toward the sky or water, and all by the means of a little wheel with a switch. On a very dark night objects at a distance of two miles away can be seen quite plainly. When fog is dense the light is thrown a distance of half a mile. The light, as located on the top of the pilot house, is connected with the regular incandescent system of the boat. By means of a weight that may be operated by a magnet, the steam fog horn of the vessel is brought under the control of the electric current. In the pilot house there are four switches controlling the circuit that runs to the search light and the fog horn, and by means of these switches the pilot can start the search light so that it will flash at regular intervals automatically; or it may be made to burn steadily; or it may be made to flash automatically at the instant the fog horn begins to bellow, and cease to flash when the bellow ceases; or the horn may automatically bellow alternately with the flashing of the light; or the flashing and bellowing may be done alternately or simultaneously by hand. No such use of electricity was ever made before. The "Connecticut's" search light was manufactured by the Scott Electrical Works, and is of 5,000 candle power. The "Rhode Island's" search light is of 4,000 candle power.

THE WENSTROM CONSOLIDATED COMPANY'S NEW FACTORY.

The Wenstrom Consolidated Dynamo Company have bought forty acres of land at Calverton, a suburb of Baltimore, for the erection of their new plant. On this property there is water-power varying from three to five hundred horse-power, the fall being 105 feet. It is the intention to sell as much of this power as will not be needed in their own factory. A considerable amount of it has already been subscribed for at $100 per horse-power year, enough they believe to pay the dividends on the whole power investment. They have also made arrangements to duplicate this hydraulic plant with steam plant so that in case of failure of the water they may be prepared. The building they are now at work on is to be 100 feet wide, and 250 feet long, two stories high, and arranged with galleries for light work. There is a basement of 100 feet square for testing, and a sub-basement of 40x100 for steam boilers, and the four Leffel turbines.

The shop is to be equipped with an electric crane, and will have the most improved machinery throughout. A large number of lathes have been ordered from the Bridgeport Machine Tool Works, also some vertical boring mills. The Betts horizontal boring mills are to be used, Browne & Sharpe milling machines, Newton's special milling machines, and a variety of other tools by various makers. It is the intention to commence work shortly upon the foundry which will have a capacity of five tons per hour.

Work on the new street car motor has already been commenced. The magnetic circuit external to the armature will be in a single casting. The motor is of the four-pole type, with the regular "Wenstrom" armature, the speed being 400 revolutions with an output of 25 horse-power, and the weight 2,000 pounds.

ELECTRICITY FOR MAGNETIC ORE MINES.

A party just in from Mesambria, the newest of the Lake Superior ranges, reports the discovery of a vein of black magnetic ore at a depth of seventy-five feet. The vein is thirty feet wide and has been traced more than a mile. An assay shows 63 per cent. of iron. The mines are located half-way between the Wisconsin Central and the Rhinelander branch of the Lake Shore. The Mesambria range people expect to get a road built down there and begin shipping from half a dozen mines this season. Mines of this class of ore are especially valuable, as the large amount of iron contained in tailings and small pieces of the rock, which has heretofore been cast aside as worthless, can now be economically utilized by means of an electrically operated magnetic separator, which divides these iron particles from the useless substances associated with them.

HEINE BOILERS FOR ELECTRICAL PLANTS.

The Columbus, (Ohio) Electric Railway Company has ordered Heine water tube steel safety boilers for its electrical power station. The Edison Electric Light Company, Chicago, Ill., has ordered 1500 horse-power of Heine water tube steel safety-boilers for its station in that city. The company has been using this type of boiler several years. R. M. Huston, 45 Broadway, New York city, is agent for these boilers.

THOMSON-HOUSTON ROADS IN BOSTON.

The West End Company still continue to increase their electric equipment, and are now engaged in laying new rails on Washington street, south of Elliott street, and on Elliott street. It is their intention to run an electric line of cars from Franklin Park through Shawmut avenue and Elliott street, to Park Square, turning about the Lincoln monument on the return. Current is now being regularly supplied from the Edison station on Head place.

A BIG NEW SWITCHBOARD FOR BOSTON.

The New England Telephone and Telegraph Company has quite outgrown its quarters at No. 50 Pearl street, and welcomes the near completion of the American Bell Telephone Company's new building at the corner of Milk and Oliver streets. The operating room of the New England Company will be on the ninth floor of the new building and will be fitted with new multiple switchboards of the latest pattern, which are now being manufactured by the Western Electric Company, of Chicago, and will accomodate 5,000 subscribers. This new multiple board will cost in the neighborhood of $100,000. The general offices of the company are to be on the eighth floor, giving a grand view of the harbor and the surrounding shores. The wires will all enter the building by underground cable, and will extend to the operating room through a large shaft or well hole. The work of removal will be arduous, but without interruption of the service.

NEW ELECTRIC ROADS FOR ST. LOUIS.

The Missouri Railroad Company, who lately increased their capital stock from $900,000 to $2,400,000, have purchased the Forest Park, Laclede and Fourth Street Railroad. Plans for their power house have been completed. A contract has been closed with Rohan Brothers, of St. Louis, for four boilers 22x60 feet, with eighteen 6 inch flues, to be arranged in two batteries. Contracts have also been closed for two Harris Corliss engines, each 30x60 feet. The countershaft will be 88 feet in length and 8 inches in diameter, fitted with Hill patent clutches. The engines will be geared to the countershaft by means of extra heavy Munson belting and 800 h. p. friction clutches. Floor space will be provided for six Thomson-Houston 75.000 watt generators, five of which will be installed at present. Thirty-six motor cars will be supplied by the Brill Car Company. Motors will be fitted in the cars at the factory before shipment.

The down-town section of the Union Depot Railroad began operation June 1st. Work on the Union Market loop and all other portions of the system is being rapidly pushed to completion. The system will embrace some twenty-two miles of track.

On account of cabling the St. Louis Railroad, the Short electric cars on the south end of that road have been laid up for a month past. The cable work is now nearly finished, and the operation of the Short electric cars will be resumed. Eight motor cars, each fitted with two new Short-Brush motors, are now ready for trial.

The St. Louis Railroad Company are contemplating a plan for operating their Seventh street section and the Cass Avenue and Fair Ground Road—which is controlled by the same syndicate—as a through line. The Short system will probably be adopted.

W. H. GORDON & CO.

The business established not long since under the above firm name by Mr. W. H. Gordon, at 115 Broadway, has already turned the corner of success, and is now handling a large and expansive trade. The company are New York agents for the Simplex wires and cables, and have found a ready appreciation of them not only in the older fields, but in the newer departments of work. Mr. Gordon deals also in a large and well selected line of electrical specialties, and is ready to give immediate quotations upon all classes and quantities of electrical goods.

THE CROSBY DRY BATTERY.

In our advertising columns this week will be found the announcement of the Crosby Electric Company, of the "Judge" Building, Fifth avenue, this city. In that card a number of interesting particulars and technical details are given, and it will be seen that the battery is strongly recommended for certain classes of work. There can be no doubt that for many special uses, the dry battery has very high qualities of advantage, and the Crosby Company proposes to meet the demand.

WHAT THE MOTOR COMPANIES ARE DOING.

In an article in the New York *Sun*, of June 21, on electric power, an idea is given of what the motor companies and their allies, the local lighting companies, are doing in familiarizing the public with the uses of electricity. One part of the article sums up the work of the ubiquitous motor as follows :—"In some cities so far has the use of electric motors gone that it is possible for a man to-day to drink at breakfast coffee ground and eat fruit evaporated by electric power. During the morning he will conduct his business with electrically made pens, and paper ruled by electricity, and make his records in electrically-bound books, his seventh-story office in all probability being reached by an electric motor elevator. At luncheon he will be able to discuss sausages, butter and bread, and at night eat ice cream and drink iced water due to the same electrical energy. He will ride all about the place in electric cars, wear shirts and collars mangled and ironed by electric motor, sport a suit of clothes sewn and a hat blocked by the same means; on holidays ride a merry-go-round propelled by electric motor, or have his toboggan hauled up the slide with equal facility, be called to church by an electrically-tapped bell, sing hymns to the accompaniment of an electrically-blown organ, be buried in a coffin of electric make, and last of all, have his name carved on his tombstone by the same subtle, mysterious, all-pervasive and indefatigable agency. This may sound like a wild and exuberant flight of fancy, but it is simply a faithful statement of the manner in which electricity is being applied to every one of the necessities and luxuries of life in America."

WESTERN TRADE NOTES.

The Ft. Wayne Electric Company are shipping apparatus of 4,000 lights capacity of the Slattery induction system to Duluth, Minn.

Keelyn and Van Denburg have purchased valuable franchises granted in Hyde Park for electric lighting and will immediately commence operations thereunder.

Mr. H. P. Lucas, of the North-Western Electric Construction and Supply Company passed through Chicago this week on his way to St. Paul, returning from an extended and highly successful business trip.

The Elgin Electric Light and Power Company have organized with $100,000 capital and have placed contracts with the Ft. Wayne Electric Co. for an installation of 5,000 Slattery induction system incandescents, and 300 new Wood arc lamps. This plant will be operated with water power.

Mr. Thos. G. Grier, one of the managing electrical and mechanical engineers of the National Engineering Bureau of Chicago, will in future take charge of the electrical department of the editorial work of our esteemed contemporary, *Electrical Industries*. The management of this journal are to be congratulated on their selection, and Mr. Grier may certainly feel satisfied with his connection.

Mr. J. E. Keelyn, of the Ft. Wayne Electric Company's Chicago office, has closed a contract with the Citizen's Electric Light and Power Co., of Hyde Park, for a central station plant of 120 arc lights and 1,200 incandescent lights. The new Wood arc and Slattery induction incandescent systems will be adopted in this station throughout. The central station is situated in Pullman, Ill., and will furnish service for lighting Pullman, Kensington, Roseland, Riverdale and other sections of Hyde Park.

The New Slattery Alternating Current Motor is spoken of as the greatest advance in this direction ever accomplished. It is now in operation in Ft. Wayne. Important features are claimed for it, notably that it will start from rest either with or without the full load and does not need to run synchronously with the generator but as regards operation and efficiency is exactly similar to the ordinary continuous current motors so widely used at the present day.

The Illinois Electric Material Co., 841 Rookery, Chicago, are now comfortably settled in their new offices and thoroughly ready for business in all kinds of electric light, power, and other supplies. They will be pleased to receive a call from their many friends and patrons and show them their numerous specialties. They now carry in stock ready for immediate shipment a full line of Bishop rubber covered wires and cables so widely known in every central station and many isolated installations. Their present excellent facilities enable them to fill orders right away upon their receipt, which is quite an important feature and much to be desired in the supply business, and one which is also highly appreciated by customers.

Mr. W. H. Harding, formerly secretary of the Baxter Electric Motor Co. of Baltimore, Md., has taken charge of the South Side Electric Company's new central station in Chicago. The plant is located on the corner of State and 20th streets, and will be equipped in the most modern and approved manner, everything pertaining to the best and latest ideas on central station building being added, and the station is expected to be a model one in the thoroughness and excellence of its steam and electrical equipment. It will have a capacity of 10,000 incandescent lights of the Ft. Wayne Electric Company's system so well and favorably known throughout the whole country. Already more than 2,000 lights have been applied for and the company are now covering the residence district of the aristocratic quarter.

The Detroit Motor Co., through Mr. W. S. Armour, their Chicago agent, have recently consummated one of the largest motor deals known. This outfit of motors is for the Columbia Theatre, and comprises one 10 h. p. for elevator work ; one 5 h. p. operating a 60 inch exhaust fan, one 5 h. p. running a 48 inch exhaust fan, these two running at a speed of from 500 to 600 revolutions per minute ; one 2 h. p. operating a 72 inch exhaust fan at a speed of 230 revolutions per minute, and 2 small fan outfits for the managers office. Among other sales is a 15 h. p. motor. This company has also placed a 5 h. p. machine in Wm. Switzer's machine shop at 22 and 24 Fourth avenue, and a 1 h. p. motor in Cutter & Crossett's factory on Franklin street, and also three 1 h. p. motors to run silver buffer and 36 inch exhaust fans.

The J. C. Walsh Gasoline Torch Mfg. Company are now in shape to fill the largest orders at shortest notice and are receiving numerous orders which they push through as fast as they come in. Great improvements have been made in the construction of their torches which are now made of one solid spun box, thereby obtaining a more perfect and handsomer article and one of greatly increased durability. When these torches were first placed upon the market, it was supposed that the main and principal channel of supply would be to the plumbers, but the promotors are agreeably surprised to find that their product is employed by every one for the finest and most delicate soldering work, which it performs in the best manner. In electrical work it fills a long felt want, making finer joints with ordinary solder than were heretofore obtained even with the employment of bismuth solder, which on account of its high price is almost prohibitive for ordinary work.

NEW ENGLAND TRADE NOTES.

The Thomson-Houston Electric Company is putting up a building at Lynn which will be devoted entirely to the manufacture of electric mining machinery.

Mr. Fritz Goldenzweig, a prominent electrical engineer, of Vienna, Austria, has been in Boston this week for the purpose of investigating electric light and railway appliances, with a view to the introduction of the best system in Vienna. He reports that Vienna intends in the near future to have an electric railroad system of from ten to fifteen miles.

The Essick Printing Telegraph continues to attract general attention, and this week a successful experiment was made of connecting Washington with Boston. Between New York and Washington, and New York and Boston, there have been instruments working perfectly for some time. A number of the railroad companies have carefully examined it, and are only waiting to have their orders filled. They see a great possibility for this instrument in helping them with their multitudinous correspondence along their various lines of railroad.

The Electric Gas Lighting Company of Boston, has secured the agency for Eastern Massachusetts of the well-known Perret automatic electric motors for all work, manufactured by the Elektron Manufacturing Company of Brooklyn, N. Y., and they intend to introduce them in connection with the Mason primary battery, for which they have also recently secured the agency for New England. They are now making arrangements for quite an elaborate display in their store to show off the merits of this excellent motor and the battery, and are already in receipt of several orders.

H. E. Swift & Company have been increasing their business so rapidly that they have found it necessary to seek larger quarters, and have taken a factory and offices at 34 Oliver street, Boston. The offices will be on the second floor and the factory, large enough to accommodate 100 hands, which is double of their present accommodation, will be on the top floor. Messrs. Swift & Company have recently admitted Mr. Walter L. Boyden as partner, and will continue the general manufacture of rosettes, fuse boxes, cut-outs, safety appliances and all incandescent light supplies in porcelain and wood. They are also at present introducing the Brodie "Tree Insulator," and have a large demand for it.

The American Circular Loom Company, of Boston, manufacturers of an improved insulated line wire, have received an order for nine miles o wire from No. 0000 to 0, from the Duquesne Traction Company of Pittsburg, Pa., for use on the Thomson-Houston Electric Railway in that city. The insulation in this wire is woven on instead of braided, which gives it a peculiarly tough finish, and makes it capable of withstanding an immense amount of abrasion. It has the appearance of a stout canvass sheathing around the conductor. The saturation of the cotton by the compound is also very thorough, and is fireproof as well as waterproof. The American Circular Loom Company bid fair to develop into one of the large insulated wire companies in a very short time, and have already a large amount of orders on their books.

The Eastern Electric Light and Storage Battery Co. of Lowell, chartered in November, 1889, was organized for the purchase of patent rights of the "Sorley" storage battery for the territory of New England, and since that purchase they have bought the one-fourth interest which the Anglo-American Co. of New York held in the Eastern Electric Light and Storage Battery Co. Increasing business made it imperative that the company should be in a position thoroughly to equip electric light plants, and with that end in view propositions were made to the firm of L. H. Derby & Co., electricians, at Lowell. The negotiations resulted in the purchase of the entire plant, and the firm, consisting of L. A. Derby, F. A. Derby and C. F. Morse, have entered the employ of the Eastern Electric Light Co., each assuming the heads of their respective departments, as heretofore. A few of the places that have been equipped by them are the Lowell Bleachery, the Lawrence Co., White Bros. & Co., tanners ; the Traders and Mechanics Insurance Co., J. Montgomery Sears' country residence, Southboro, Damon Safe Works, and several of the largest buildings in Boston.

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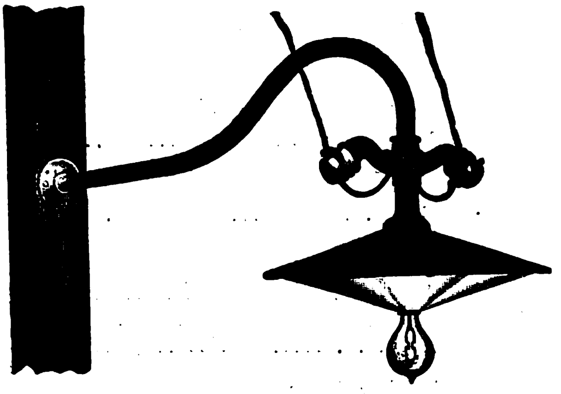

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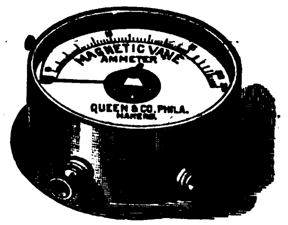

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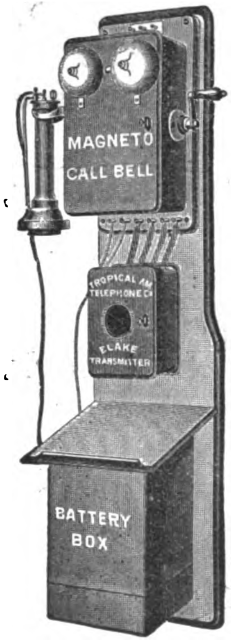

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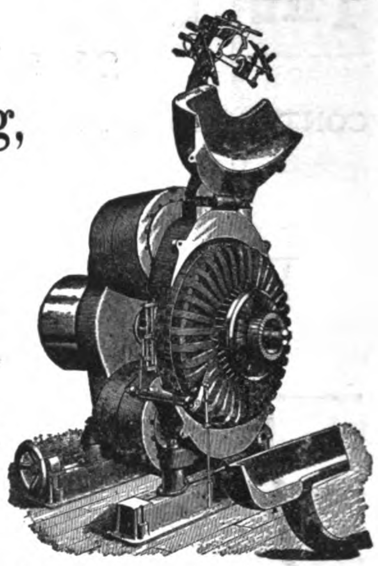

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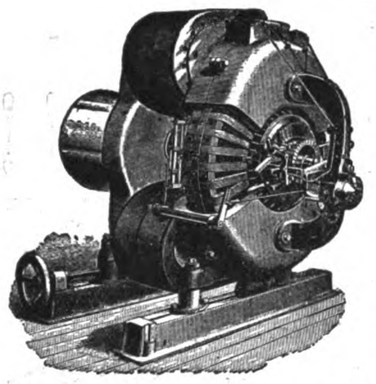

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½ to 36 CANDLE POWER. 2½ to 40 VOLTS.

FOR BATTERY OR DYNAMO.

These Lamps can be used in Series on Dynamo Circuits for all kinds of Decorations and Displays.

WE WILL SEND FREE CATALOGUE E,

which gives prices and descriptions of Lamps, and directions

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to operate them. Any intelligent boy can make these batteries under the directions given.

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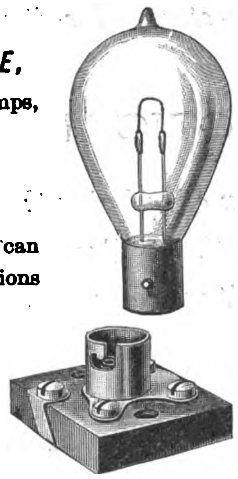
HARRISON, N. J.



SIMPLEX WIRE.

FOR ELECTRIC LIGHT AND RAILWAY SERVICE.

THE MOST ECONOMICAL BECAUSE IT IS THE BEST

It demonstrates its own Superiority.

High Insulation. Unequaled Resistance to Moisture and Abrasion. Sizes from No. 0000 to No. 18 B. & S. G

ANOTHER TESTIMONIAL.

NEW BEDFORD GAS LIGHT COMPANY,
NEW BEDFORD, MASS., May 18, 1889.

A. F. Mason, General Manager:

DEAR SIR: Yours of May 9 is at hand. You ask me in regard to our opinion of the Simplex Wire, its economy, etc. In answer, I would say that our experience of the past year has taught us the necessity of the best insulation for both arc and incandescent wires, both in economy of coal consumed and in safety to life and property.

We have used your "Simplex Wire" on this account, and are perfectly satisfied, in fact I think our immunity from any accident the past year on the lines is largely due to your insulation. Yours truly, ROBT. B. TABOR.

THE SIMPLEX ELECTRICAL CO., 620 Atlantic Ave., Boston, Mass.

SELLING AGENTS.

George Cutter, 80 Adams St., Chicago, Ill.
W. H. Gordon & Co., 115 Broadway New York City.

THE ELEKTRON MFG. CO.,

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MANUFACTURERS OF

Perret * Automatic * Electric * Motors

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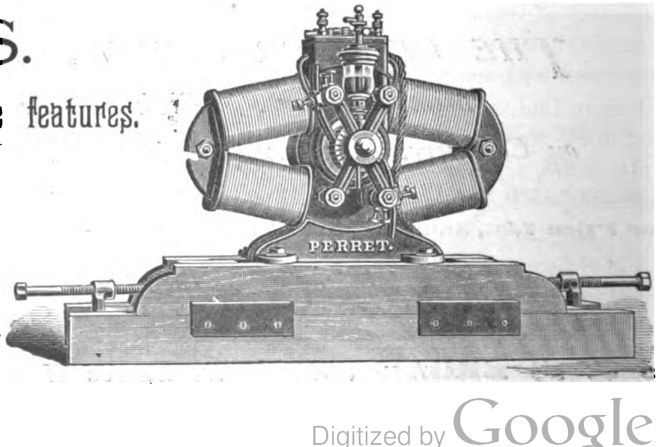
Embodying Latest Improvements and all desirable features.

HIGH STANDARD OF WORKMANSHIP,
HIGH EFFICIENCY, LOW SPEED,
PERFECT REGULATION, SIMPLICITY.

Motors for Running Shops, Elevators and Machinery OF ALL KINDS.

FAN OUTFITS FOR BATTERY OR ELECTRIC LIGHT CIRCUITS.

ISOLATED PLANTS for Incandescent Electric Lighting.



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RAILWAY SYSTEM.

MORE than One Hundred different Street Railways in Operation or in Course of Construction.

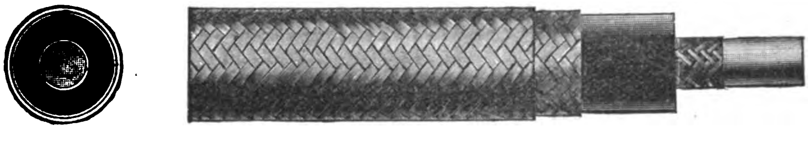
MORE than One Hundred and Seventy-five separate Orders from Street Railways for Electrical Equipments.

THE SPRAGUE ELECTRIC RAILWAY SYSTEM HAS BEEN PROVED TO BE THE

Most ‡ Durable, ‡ Reliable, ‡ Economical ‡ and ‡ Convenient.

SPRAGUE ELECTRIC RAILWAY & MOTOR CO.,
16 and 18 Broad Street, New York.

The "CLARK" WIRE



INSULATION GUARANTEED WHEREVER USED, AERIAL, UNDERGROUND OR SUBMARINE.

In a letter from the Inspector of the Boston Fire Underwriters' Union, under date of March 29, 1886, he says:
"A THOROUGHLY RELIABLE AND DESIRABLE WIRE IN EVERY RESPECT."

THE rubber used in insulating our wires and cables is especially chemically prepared, and IS GUARANTEED TO BE WATERPROOF, and WILL NOT DETERIORATE, OXIDIZE or CRACK, and will remain flexible in extreme cold weather, and is not affected by heat. The insulation is protected from mechanical injury by one or more braids, and the whole slicked with Clark's Patent Compound, which is water, oil, acid, and to a very great extent fire-proof. OUR INSULATION WILL PROVE DURABLE WHEN ALL OTHERS FAIL. We are prepared to furnish Single Wires of all gauges and diameter of insulation for Telegraph and Electric Lights from stock. Cables made to order. We are now prepared to furnish our Clark Wire with a WHITE OUTSIDE FINISH for ceiling cleat work as well as our standard color.

CLARK JOINT GUM should be used for making water-proof joints. This is put up in half-pound boxes, in strips about one foot long and five-eighths inch wide, and when wrapped about a joint and pressed firmly it makes a solid mass.

FOR RAILWAY AND MOTOR use, we make all sizes of stranded and flexible cables with Clark insulation. Wire Tables and price-list will be furnished on application to

HENRY A. CLARK, General Manager.
HERBERT H. EUSTIS, Electrician.

EASTERN ELECTRIC CABLE COMPANY,
61 to 65 Hampshire Street, Boston, Mass.

WM. S. TURNER. J. LESTER WOODBRIDGE.

WOODBRIDGE & TURNER, Electrical Engineers and Contractors. Complete equipment of Railways, Steam Plants for Electric Light and Power. Arc and Incandescent Lights installed. Designs and Estimates submitted.

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THEY ALL USE IT! What? The "SAMSON" Battery. Who use it? Why, Electrical Contractors and Fitters, Independent Telephone Managers, and all parties who want the STRONGEST and MOST DURABLE OPEN-CIRCUIT BATTERY MADE.

THE ELECTRIC GAS LIGHTING Co., Boston, Mass.
Sole Mfg. Agents for United States.

THE ELECTRICAL TESTING BUREAU
—OF THE—
JOHNS HOPKINS UNIVERSITY
WILL BE CLOSED UNTIL OCTOBER 1st, 1890.

FINANCIAL.

The Automatic Phonograph Exhibition Company, of New York City, has filed a certificate of an increase of its capital stock from $1,000,000 to $2,500,000.

See further, page xii.

R. D. WILSON & CO.,
PROMOTERS AND DEALERS IN
ELECTRIC SECURITIES EXCLUSIVELY,
Offer a limited number of shares of the Treasury Stock of the
New England Printing Telegraph Company.
CAPITAL, $1,500,000. PAR VALUE, $50.

President, FRANK B. DOLE, Boston.
Directors:—FRANK B. DOLE, JAMES P. COOK, Boston; GEO. W. SLADE, Fall River; JOHN R. REED, Westfield, Mass.; ABNER McKINLEY, Canton, Ohio; P. S. JENNINGS, New York.

This Company is the Licensee for the New England States, of the Essick Printing Telegraph System. The office of the Parent Company is at 171 Broadway, New York City, where an exhibition line to Boston may be seen in operation.

"*I have examined the system, and see in it new Electrical features which are very valuable, and believe that the system is thoroughly practical for all telegraphic purposes.*"—MOSES G. FARMER.

Correspondence invited; further information furnished, and an exhibition of the system may be seen at
113 DEVONSHIRE STREET, Room 21, BOSTON.

Massachusetts Electrical Engineering Company,
STONE & WEBSTER, MANAGERS.
No. 4 POST OFFICE SQUARE, · · BOSTON, MASS.

CONSULTING ENGINEERS:
W. W. JACQUES, PH. D., Electrician, American Bell Telephone Co.
S. W. HOLMAN, S. B., Prof. of Physics, Mass. Institute Technology.
EDWARD SAWYER, C. E., Mill and Hydraulic Engineer.
GEO. W. BLODGETT, S. B., Electrical Engineer, Boston & Albany R. R.
ARTHUR L. PLIMPTON, S. B., Engineer, West End Street Railway Co.

LATTICED ✱ IRON ✱ POLES

MADE BY THE

Wisconsin Bridge and Iron Company.

Strongest and best Poles ever made. Ornamental and reliable, holding the Trolley wire up in the best manner. Recommended by the leading Electric Railway systems, as they combine maximum Strength and Durability, with the highest possible Economy. Estimates furnished. Address the Agents,

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MANUFACTURERS AND DEALERS IN
ELECTRIC RAILWAY SUPPLIES,
11 ADAMS STREET, opposite Pullman Building, CHICAGO.

KEELYN & VAN DENBURG,
185 DEARBORN STREET, CHICAGO, ILL.

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ELECTRICAL POWER,
WATER WORKS, ETC.

FOR COMBINATION OR INDIVIDUAL PLANTS CORRESPOND WITH US.

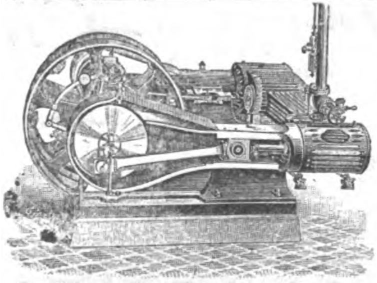
The Empire City Electric Company,
15 DEY STREET, NEW YORK,
Manufacturers of and Dealers in
ELECTRICAL ✱ SUPPLIES
OF EVERY DESCRIPTION.
SEND ∵ FOR ∴ CATALOGUE ∵ AND ∴ QUOTATIONS.

THE
Illinois Electric Material Co.,
ELECTRIC LIGHT AND POWER SUPPLIES.

Bishop "White Core" Wire.

Best Rubber Covered Wire in the Market, for Incandescent Wiring.

341 Rookery Building, Chicago, Ill.



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PLAIN AND COMPOUND.
The Most Simple, Durable and Economical
AUTOMATIC CUT-OFF ENGINE IN THE WORLD.
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FOUNDRY and MACHINE DEP'T,
Harrisburg Car Manufacturing Company.) HARRISBURG, PA.

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Will be pleased to receive CATALOGUES, PRICES and DISCOUNTS, and FULL INFORMATION regarding
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W. H. GORDON & Co.,
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NEW YORK AGENTS FOR
Simplex Wires and Cables.
DEALERS IN
High Grade Supplies and Appliances
FOR ELECTRIC LIGHT AND POWER.

ELECTRIC LIGHT.

The Standard Electric Company of Vermont has put in over forty plants during the past year, aggregating 10,450 lamps.

Navasota, Tex.—It is proposed to put in an incandescent plant in connection with the new water works, of which E. H. Haver is superintendent.

Braddock, Pa.—The Citizens' Electric Light Company, of Braddock, Pa., intend building a new station and will increase their plant by a Westinghouse 750 light alternating incandescent and a 50 light Thomson-Houston arc. W. S. Kuhn is the secretary of the company.

Pensacola, Fla.—The Pensacola Electric Light and Power Co. is doubling its plant, of the Thomson-Houston system, run by Ball engine and Schieren belting. Mr. E. G. Quina is the secretary and treasurer. The company has in use about 7 miles of circuit of underwriters' wire.

ELECTRIC RAILWAYS.

Japan.—K. Nakamura of Japan, is in this country to purchase equipment for a street railway at Tokio.

Milwaukee, Wis.—The consolidation of the Milwaukee City and Cream City railways has been effected. Both roads are owned by Eastern syndicates, and the deal is said to have been consummated in the East. It is reported that the Hinsey electric line is also included in the consolidation, but this is denied by Mr. Hinsey, who returned lately from the East. Both the Cream City and Milwaukee City lines will now be transformed into an electric system. The National Home and North Greenfield railroad company and the Milwaukee and Wauwatosa Motor line are about to pool issues and operate both systems under one management. The new deal contemplates the building of eleven miles of extra main and spur tracks at an additional cost, including equipment, of about $250,000.

See further page xiia.

UNITED

EDISON MANUFACTURING CO.

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The Pioneer System of
Incandescent
Electric Lighting.

LAMPS

Supplied of any Candle-
Power and Voltage
To Fit any Socket.

DYNAMOS
Constructed of any Capacity and for
every Description of
ELECTRICAL WORK.

CONTRACTS
made for Complete Installation.

No Sub-Contracts. No Division of
Responsibility.

SEND FOR PRICES.

United Edison Manufacturing Co.

65 FIFTH AVENUE, NEW YORK.

CHICAGO. SAN FRANCISCO. DENVER. TORONTO, CAN.

ELECTRIC LIGHT.

Woodsville, Pa., is to have electric lighting.

Lansdale, Pa., is to have an electric lighting plant.

Keeseville, N. Y. is to have a Thomson-Houston plant.

Fort Worth, Tex.—Heck & Baker have a contract for street lighting.

Fairbury, Neb.—The City Council contemplates putting in an electric light plant.

Malvern, Pa.—An Edison Company is to be formed. It is promised a franchise.

Gordon, Pa.—Hon. D. D. Phillips is interested in a plant to be put in at a cost of $10,000.

Tarpon Springs, Fla.—The Occidental and Improvement Co. will put in an electric light plant.

Paducah, Ky.—The Paducah Gas Light Company is putting in a Thomson-Houston plant of 50 arcs.

Quitman, Ga.—A local company is to be given a 10 years franchise, and city lighting at $1800 a year.

Lock Haven, Pa.—Blanchard & Shultz, of Philadelphia, propose to establish a plant at Lock Haven.

Stuart, Ia.—N. Wilkin, of the Hawkeye Electric Manufacturing Co. proposes to start a plant at Stuart.

Blaine, Wash.—The Blaine Electric Light and Power Co. has been formed, with a capital stock of $50,000.

Como, N. J.—H. H. Yard is to put in a plant at Como, for lighting that place, Belmar, Spring Lake and Sea Girt.

East Forks, N. D.—L. P. Ordway, St. Paul, has made a proposition to furnish any electric light plant and water works.

Haywards, Cal.—The Haywards Electric Light Works have been started by S. D. Ingram, J. H. Farrell and D. Chisholm.

Dayton, Wash.—The Dayton Electric Light Co. has begun work on its station, and will put in a plant of 50 arcs and 600 incandescents.

Media, Pa.—The Media Electric Light Company will increase its plant this fall by putting in another dynamo and an engine of 50 h. p., etc.

The Wightman Electric Manufacturing Company has been formed at Scranton, Pa., by Merle J. Wightman and others, with a capital stock of $30,000.

Hoquiam, Wash.—The Aberdeen and Hoquiam Electric Railway Company will establish an electric light plant in connection with its street railway system.

Lake Geneva, Wis.—The Lake Geneva Water and Light Co. has been formed, with a capital stock of $40,000, by J. E. Heg, E. P. Wheeler and J. C. Reynolds.

Greenwich, Conn.—The Greenwich Gas and Electric Light Co., R. B. Owens, superintendent, has started up its Thomson-Houston plant very satisfactorily.

Milwaukee, Wis.—The Milwaukee Light and Power Company will put up a power house on Commerce and Galena streets, which is to be in readiness by September.

Louisville, Ky.—The Louisville Gas Company will locate the station it proposes to build for electric lighting on the site of the First Presbyterian Church, on Green street.

Chester, Pa.—The Chester Electric Light and Power Company of Chester, Penna., is increasing its facilities by putting in a larger engine and two additional dynamos.

Johnstown, N. Y.—The Johnstown Electric Light and Power Company has secured the contract for two years, at $75 per light per year, the company to supply 50 lamps or more.

Westerly, R. I.—The Westerly Gas and Electric Light Co. has elected for the current year E. Babcock, president; A. Perry, secretary and treasurer; and J. H. Hodgson, superintendent.

Elizabeth, N. J.—A syndicate of wealthy New York capitalists is said to have obtained control of the plant of the Schuyler Electric Light Company of Elizabeth, N. J. It will increase its capacity thrice.

Las Vegas, N. M.—J. H. Gates, Westinghouse agent, has secured an order from the Las Vegas Gas Co. for 40 arcs and 750 incandescents, both machines alternating, and for a 100 h. p. Westinghouse compound engine.

Rock Hill, S. C.—The Rock Hill Electric Light Co. has a capital stock of $10,000. J. M. Cherry has been elected president and D. Hutchison, secretary and treasurer. The company has not bought a plant yet, and is in need of a complete outfit.

New York City.—Judge Coxe has declined to grant the motion of the Brush Electric Light Co. for a rehearing on his recent decision in favor of the Brush-Swan Co. as sole agent in this district for apparatus and machinery manufactured by the defendant company.

Pittsburgh, Pa.—The Thomson-Houston Co. has closed a contract with the Pittsburgh Plate Glass Co., for its city works, for 1,356 incandescent lights and an electric tramway with four electric locomotives for hauling plate glass through the works. The plant requires 300 h. p. of engine, etc.

San Antonio, Tex.—The San Antonio Gas Co. bought recently the plant of the Electric Light and Power Co. It is remodeling the plant, and has ordered two 750 Westinghouse alternating lighters, a 320 h. p. Westinghouse compound condensing engine and a 700 h. p. Holyoke Deane condenser.

☛ **Binghamton, N. Y.**—The Binghamton Electric Company has been incorporated with a capital stock of $200,000. The corporation is organized for a term of fifty years, for supplying electric light. The following are directors: George J. Morse, Hyde Park, Mass.; Geo. W. Dunn, Geo. F. O'Neil and John Anderson, Binghamton; W. H. Roberson, Harry F. Roberson, Frank Sterry, Albany.

Kansas City, Mo.—The Interstate Electric Company of Kansas City, Mo., has assigned to William Allbritain. The property consists of a number of cells of storage batteries, wires already put up, and poles, office furniture and fixtures, machinery consisting of two steam engines and five boilers, a franchise from the city, some electrical lamps and electrical sundries, and some accounts, a total valuation estimated of $6,000.

Stoneham, Mass.—The reports given by the New England papers as to the rates for lighting the town of Stoneham by the Woburn Electric Light Co. appear to be incorrect. Instead of being 90 cents for a light to 12.30 a. m., the price of arc lights is about $87 per year, and is below the price named for lighting the town of Melrose, referred to at 60 cents a light; while the maximum price showed by the Malden Electric Co. (which lights Melrose) in its operations is $100 per light per year.

Atlanta, Ga.—The newly created Board of Electrical Control, Atlanta, Ga., recently held its first meeting in that city. Alderman J. G. Woodward, a chairman of the Light Committee, became ex-officio chairman; Chief of the Fire Department W. R. Joyn was made secretary; City Engineer R. M. Clayton is the other member of the board. Mr. W. B. Walker was elected superintendent of electrical affairs, and will take charge of all matters pertaining to electric wire and other apparatus that come within the jurisdiction of the city.

ELECTRIC RAILWAYS.

Great Falls, Mont.—The new electric road is to run to the Montana smelter and Giant Springs.

Oakland, Cal.—The Pacific Improvement Co. will change their road on Telegraph avenue either to electricity or to cable.

Salina, Kan.—The street railways are being consolidated by Eastern capital, and the United system is to be operated by electricity.

Columbus, O.—Mr. J. S. Crump will operate his new 4 mile road by horses at first, but it is his intention to adopt electricity ultimately.

Boise City, Idaho.—G. A. Insley, and others, have secured a franchise for an electric road, of which 2½ miles are to be finished within a year.

Atchison, Kan.—An electric railway company has been formed, with G. Storch, president; W. W. Hetherington, treasurer; and G. H. Williams, secretary.

Champaign, Ill.—The Champaign and Urbana street railway, owned by F. L. Jaques, has been granted permission to extend its lines, on condition that it will operate electrically within the next two years.

Danvers, Mass.—At a meeting of the stockholders of the Beverly and Danvers electric road, it was voted to ask the railroad commissioners for permission to increase their capital stock $18,000, making a total of $25,000. It was voted to build an annex to the present power station on Elliott street, for a waiting room and workshop. The directors were instructed to petition the selectmen of Danvers for permission to connect with and run over the tracks of the Naumkeag street railroad from Danversport to the plains. The directors were authorized to lease the road if they thought expedient.

Newark, N. J.—The Philadelphia syndicate which recently acquired control of the Essex (N. J.) passenger railway system and of the Newark and Irvington line has just completed the transaction by receiving nearly all the stock necessary to give them the syndicate ownership. Checks to the amount of $1,650,000 have been paid to John and Robert Ballantine, William Clark, A. Q. Keasbey, S. Battin, Andrew Lemassena, Wolcott Jackson, and others. The price of each share of stock was $350. A temporary organization has been effected, and a permanent organization will be had at a meeting to be held shortly. The new Board of Directors will have three representatives of the old companies.

Orange, N. J.—The Essex Passenger Railroad Company, whose line extends from Newark to Orange, has petitioned the Common Council of Orange for permission to operate its cars by electricity with the overhead system of wires carried on poles. The petition has been referred to the railroad committee, and will probably be adversely reported upon, the public sentiment in Orange, it is believed, being opposed to the overhead system of wires for running cars. The company, however, is going to operate its cars by that system in Newark, as are all the other street railroads there, the city authorities having granted that privilege to the syndicate which owns them, as well as the Essex Passenger Railway Company.

Lawrence, Mass.—One of the most important business transactions of late years was consummated on June 6 in the sale of the Merrimac Valley Horse R. R. to a syndicate of railway men of Boston and Newburyport. It is probable that the concern will be known as the Boston Construction Co. The sale made was of about 720 of the 800 shares of stock, the price said to be $150 a share. The par value is $100, and the last sales were made at $125. The road connects Lawrence with the outlying towns of Andover, Methuen and North Andover, as well as the suburbs, has been in operation 22 years, and under its recent management has greatly extended its track and increased its facilities. Franklin Butler, president of the board of trade, is president; Hon. Byron Truell, of the governor's council, vice-president, and A. C. Butler, cashier of the Arlington bank, treasurer. The sale is supposed to be part of the scheme for a route between Newburyport, Haverhill and Lawrence by a line of electric railway. Two other roads are alleged to be already under the control of the same syndicate. The sale was a great surprise to everybody.

Dublin, Tex.—The new street railway company, formed by A. A. Chapman, and others, has a capital stock of $15,000. The road will be 3 miles long, and it is proposed to operate it at first by mule power.

ELECTRIC POWER.

Chicago.—The Belding Motor and Manufacturing Co. state that they are thirty days behind their orders on motors.

Muskegon, Mich.—The Muskegon Machine and Foundry Company, of Muskegon, Mich., has been formed by the consolidation of two companies, one from Norwalk, Ohio, and the other from Toledo, Ohio, to engage in the manufacture of sewing machines and various kinds of light machines. A leading feature will be the manufacture of sewing machines and an electric motor to furnish power for the same.

TELEGRAPH.

The Telegraph Conference.—A special dispatch from Paris, of June 19, says: The telegraph conference to-day finally rejected the German proposal to double the price of code words; also the Austrian proposal that ten words be the minimum in a message; also the British proposal that five words be the minimum. A reduction of the tariff between England and Malta, Gibraltar, Spain and Portugal was announced.

WATER POWER.

Farmington River, Conn.—The new power company that is to use the power of the Farmington River, ten miles from Hartford, for generating electricity for the Hartford electric light station, has been duly organized. It is known as the Farmington River Power Company, with a capital of $80,000. The undertaking is an extensive one, as it is proposed to transmit a 3,000-volt current ten miles to a 250 horse-power motor in the electric light station at Hartford. The directors: J. L. Howard, E. C. Terry, W. H. Goodrich, L. A. Barbour, E. B. Bennett, Henry Roberts and Atwood Collins.

NEW HOTELS.

Abecon, N. J., is to have a new hotel with electric bells, etc.

Richland, Ga.—A new hotel and bank block is now being erected.

Fort Worth, Tex.—M. B. Lloyd, W. M. Harrison and others propose building a new hotel.

Barrow, Va.—The Barrow Improvement Company will build a $60,000 hotel with electric bells, etc.

Ellicottville, N. Y.—B. J. Crawford will build a new hotel with 61 rooms, and put in electric bells, etc.

Cleveland, O.—Putt & Wilmot's hotel, on Ontario and Prospect, is to be remodeled and to have electric lights, bells, etc.

Crawfish Springs, Tenn.—Gen. J. T. Wilder and others propose building a large hotel at Crawfish Springs, near Chattanooga.

Salt Lake City.—The new Hotel Ontario will be a 5-story building, costing $600,000. It will have electric lights, electric bells, electric annunciators, etc.

Chicago.—S. H. Gwathmey, will build a $100,000 hotel, called the Argyle, on 63d street, near the Eastern Illinois depot, to have electric lights, electric bells, annunciators, etc.

Chicago.—Goeffmey Bros. will build a 5-story and basement hotel on 63d street, near the Illinois Central Railroad depot, to cost $70,000. It will have electric annunciators, electric bells, etc.

Cumberland Island, Ga.—It is stated that T. Henley, G. M. Davis, C. A. Ellis and F. Whitehead, of Macon, Ga., propose building a summer hotel, etc., at Cumberland Island, near Brunswick.

Kensington, Ga.—The Kensington Land Company, F. R. Pemberton, president, is to build a hotel at a cost of $30,000, which will be lighted by electricity and contain electric bells, annunciators, etc.

NEW BUILDINGS.

Aurora, Ill., is to have a $75,000 government building.

Dubuque, Ia., is to have a new court house costing $125,000.

Pittsburgh, Pa.—The Baltimore and Ohio Co. will spend $400,000 on a new depot, etc.

Union City, Ind.—The Pythian Opera House Company will build a theatre and use electric lights in it.

Palmer, Mass.—The Memorial Building is to be equipped with electric lights. Mr. A. Pinney has charge of the matter.

Manitou, Col.—The Manitou Auditorium Co. has been formed to build a large hall, to cost $50,000. J. M. Hulbert is interested.

Findlay, O.—The Brilliant City Brewing Company, J. Stark, president, will build a fine brewery equipped for incandescent electric lighting.

Phœnix, Ariz.—J. D. Monihan is to build a lodge room and office block fitted up for incandescent light. Electric bells, etc., will also be put in.

GREAT WESTERN
ELECTRIC
SUPPLY COMPANY,

190 & 192 Fifth Avenue, ∴ ∴ *CHICAGO.*

A LARGE STOCK OF THE CELEBRATED

SIMPLEX WIRES

TO SHIP FROM.

Bernstein Incandescent Lamps,
Hill's Main Switches,
Cutter's Combination Tin Shade,
Cutter's Brush Trimmer,
Bryant Incandescent Switches,
Cutter's Incandescent Street Hood,
Cutter's Porcelain Cut-outs,
Russell Mast Arms.

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In the Model Shop; look out for it.

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White Core Wires,

B. D. Wires,

Competition Line Wires.

Grimshaw Tapes,

Grimshaw Splicing Compound.

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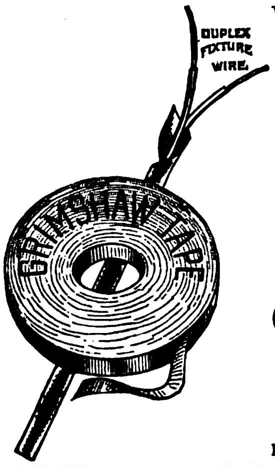
Southwestern Electrical Supply Co. Kansas City, Mo.
St. Louis Electrical Supply Co., St. Louis, Mo.
The Central Thomson-Houston Co., Cincinnati, O.
Kendall & Slade, Boston Mass.
Fisher Electric Co., Detroit, Mich.
Dayton, Hall & Avery, Portland, Oregon.
Thos. F. Day & Co., San Francisco, Cal.
North-west Thomson-Houston Co., St. Paul, Minn.
Southern Electrical Mfg. & Supply Co., New Orleans, La.
Bagnall & Hillas, Yokohama, Japan.

Office: 649 & 651 BROADWAY, N. Y.

R. E. GALLAHER, Sec'y. J. W. GODFREY, Gen'l Manager. W. B. DOWSE, Supt.



New Tangye Buckeye Automatic Cut-off Engines.

In Use, over 2,500. 25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and Superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 200 H. P. for driving Dynamo Machines a Specialty. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail.

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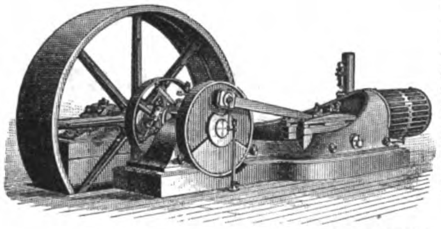

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USE THE NOISELESS PATENT
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NO METAL REQUIRED
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THE NEW PROCESS RAW HIDE Co.
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The Whitest Thing on Earth. * * *

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A FIREPROOF, INSULATING, WATER PAINT.

SPECIALLY ADAPTED FOR WALLS OF ELECTRIC LIGHT STATIONS. WILL NOT RUB OR FLAKE OFF.

WILLIAM D. WARNER,
135 Pearl Street, Boston, Mass.

ELECTRIC LIGHT.

Sherman, Tenn., has been enlarging its city plant.

Selma, Ala.—The Matthews Cotton Mill Company will put in an electric light plant.

Cartersville, Ga., is to have an electric light plant put in by capitalists of Rome, Ga.

Kimball, Tenn.—The Kimball Town Company proposes putting in an electric light plant.

New Decatur, Ala.—The Decatur Electric Light and Power Company will increase its plant.

Milledgeville, Ga.—The Milledgeville Electric Light Company is to put in a new incandescent machine, new engine boiler, etc.

Yazoo, Miss.—C. A. Collins, the chairman of the committee on street lighting, is inviting correspondence on the subject of electric lighting.

Three Forks City, Ky.—The St. Helen's Improvement Company, of 307 West Main street, Louisville, will put in an electric light plant at this new city.

Chicago.—S. S. Beman has made plans for a power house for the Edison Electric Light Co. to be erected on Twenty-sixth and Indiana avenue, 70 x 148 feet, at a cost of $18,000.

Morganton, N. C.—The contract for the electric light plant has been let to the Westinghouse Electric Light Company, of Pittsburgh, Pa. It is to have capacity for 25 arc and 750 incandescent lights.

Birmingham, Ala.—The furnaces of the Vanderbilt Steel and Iron Company, Birmingham, will be lighted by apparatus of the Easton Electric Company, of New York, purchased through the Southern agent, W. A. Wright, Birmingham.

Yazoo City, Miss.—L. M. Fishback, representing the Thomson-Houston Electric Company, of Boston, Mass., will, it is stated, submit a proposition to the town council for the erection of an electric light plant and the construction of water works at an estimated total cost of $40,000 to $50,000.

Concord, N. H.—The foundation for the new electric light station of the Concord Co. has been started. The building will be of brick, one story, the main part 68 x 90 feet with engine room in L. A 100 feet chimney will be erected. The power will be supplied by two new steel boilers, and one additional engine will be put in, besides several new dynamos. The work will be pushed rapidly, and it is expected to have the plant ready for operation by Sept. 15.

Oshkosh, Wis.—The Oshkosh Electric Light and Power Co. now has a capital stock of $60,000. C. C. Paige is president, superintendent, etc. T. D. Grimner is secretary and H. B. Hurshaw, vice-president. The plant is of the Thomson-Houston system, and comprises 300 h. p. of Ball engines, driven by Munson belts. Okonite and simplex wire is used, and there are over 65 miles of circuit. The company now propose extensive additions and are receiving proposals.

Santa Cruz, Cal.—The Swanton & Clark Electric Co. has organized as the Santa Cruz Electric Light and Power Co. H. H. Clark is president; J. F. Appleby, vice-president; A. P. Swanton, treasurer; F. W. Swanton, secretary; C. E. Lilly, electrician. A plant of the Thomson-Houston alternating system has been put in. It comprises also a Fraser Chalmers Corliss engine of 250 h. p., and a Taylor Beck engine of 85 h. p., with 3 Atlas boilers. The "Shield Brand" wire of the Electrical Supply Co. of Chicago is used.

ELECTRIC RAILWAYS.

Beverly, Mass.—The Naumkeag Street Railway Co. have bought the land for their large new power station.

Asheville, N. C.—The Asheville Street Railroad Company will extend its road to Biltmore, the winter seat of Mr. Vanderbilt.

Chicago.—The Cicero and Proviso Electric Street Car Co. have applied for permission to build their road. There will probably be no difficulty in the matter.

See further, page xvi.

"NOT HOW CHEAP, BUT HOW GOOD."

Western • Power • Construction • Co.

CAPITAL, $500,000 PAID UP.

SPECIALTIES:

THE CONSTRUCTION OF COMPLETE POWER PLANTS FOR

ELECTRIC LIGHT, RAILWAY DUTY AND POWER.

McINTOSH & SEYMOUR ENGINES,

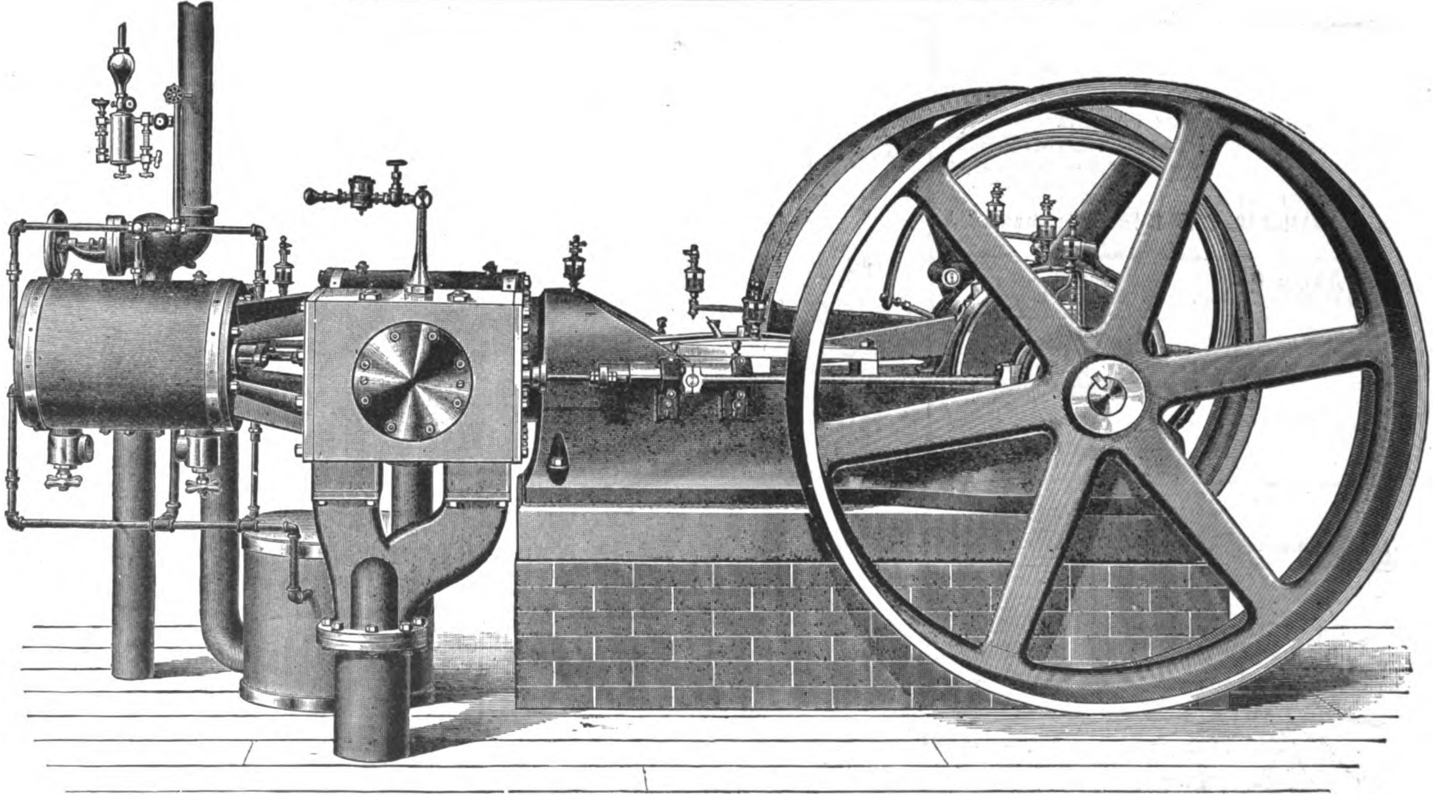
COMPOUND AND HIGH PRESSURE.

WALDO P. ADAMS,
General Manager.

MAIN OFFICE, 144 ADAMS ST.,
ROOKERY BUILDING, CHICAGO.

PROSPECTUS. The above Company, as outlined, is now prepared to make proposals for the complete erection and construction of Power Plants. Their motto in business will be :—

"NOT HOW CHEAP, BUT HOW GOOD."



McINTOSH & SEYMOUR TANDEM COMPOUND ENGINE.

We Steam-jacket our Cylinders; other makers do not. The Best and Simplest Governor in the world.
We use super-heated Receiver; other makers do not. Automatic Relief Valves. Patented Valve Seat.

THE BEST ENGINE.

"NOT HOW CHEAP BUT HOW GOOD."

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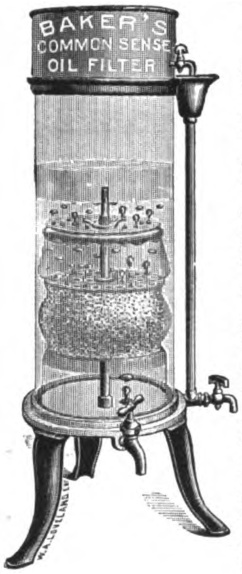
Common Sense Oil Filter.



10 Reasons Why You Should Buy It.

1.—It will save wasting a large share of your oil, that costs money.
2.—It will allow the operator to use oil as freely as is necessary.
3.—It insures parts running cool that are liable to heat.
4.—It saves extreme close attention, as oil can be fed better in a moderate quantity than when stinted very close.
5.—It saves trouble, stops, and costly delays.
6.—It saves repairs, and extends the life of your machinery.
7.—It filters the oil so thoroughly that it is as good as new.
8.—It allows the same oil to be used from five to forty times.
9.—It is the only Oil Filter that has the whole operation visible, and this makes it an unqualified success.
10.—It will soon pay for itself in $'s and requires little care.

SEND FOR CIRCULARS AND DISCOUNTS.
Manufactured and for sale by
WALTER E. CRANE,
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NEW ENGLAND AGENT.

REDDING ELECTRIC CO.,
48 HANOVER STREET,
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Manufacturers of
Electric Watchman's Printing Clocks, Electric Bells, Batteries, Annunciators and all kinds of wood and metal push buttons.
Prices as low as the lowest. Send for Catalogue.

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CONNECTORS AND TERMINALS,
For all Electrical Purposes. Incandescent Lamp and Cut-Out Terminals for all makes of Lamps.
General Electrical Supplies.
The C. McINTIRE CO., 13 and 15 Franklin St., Newark, N. J.

Marion, N. C.—The Marion Street Railway and Hotel Company has a capital stock of $100,000, and will build an electric or dummy road one and one-half miles long.

North Yakima, Wash.—W. Ferguson. L. Mac Lean, C. V. Massey, and others, of Spokane Falls, will build an electric road at Yakima, where they are interested in real estate.

Lowell, Mass.—The Lowell and Dracut Street Railway Co. will, it is said, put in a power plant for their road instead of taking their power as heretofore from the electric light station.

The Wheless Electric Railway Co. has been formed at Alexandria, Va., with a capital stock of $1,750,000. Mr. J. L. Beach represents the company, which has been trying its system in Washington with success.

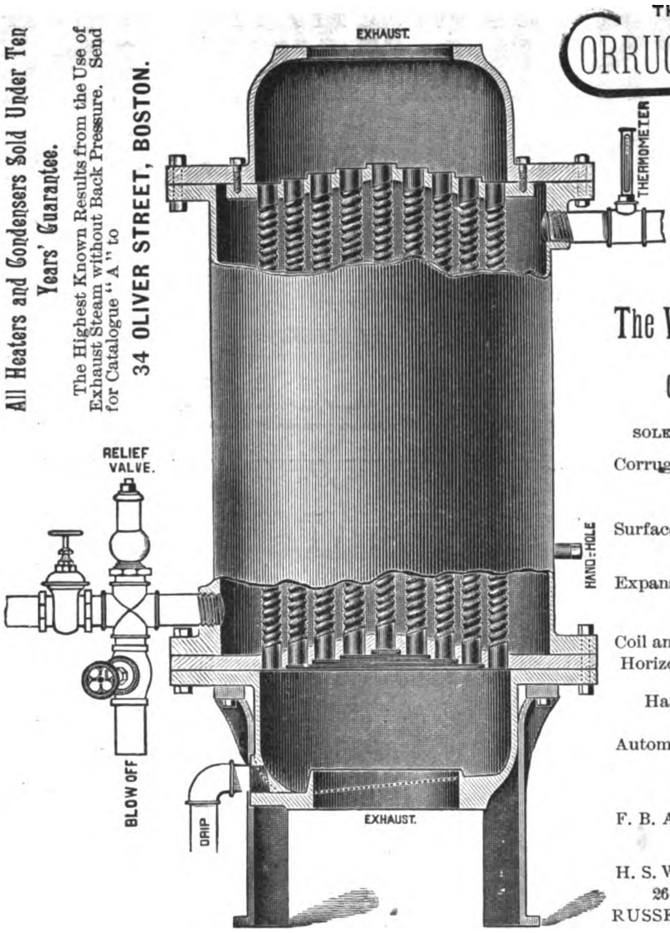
Long Island City, N. Y.—There was to be a hearing at 2 P. M. on June 16 before the Railroad Commission in Albany on the application of the Long Island City and Newtown Street Railroad Company for permission to change its motor power from horses to electricity.

South Baltimore, Md.—The Baltimore, South Baltimore and Curtis Bay Railway Company has been formed, with a capital stock of $50,000, and with W. S. Rayner as president and W. C. Pennington as secretary. It intends building a five mile electric road to Curtis' Bay.

East Orange, N. J.—The East Orange Township Committee is considering the request of the Essex Passenger (horse-car) Railroad Company for leave to extend its lines further through the township, and also to erect poles and wires for the purpose of running its cars by electricity.

Brockton, Mass.—The electric road between Whitman and Brockton is given up for a time, and nothing will be done in carrying out the plans this year. The trouble lies mainly in the slowness of the selectmen in granting a franchise. The road will probably be finished sometime next spring in order to start up for the summer travel.

See further page xviii.



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FEED WATER
HEATER.

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SOLE MANUFACTURERS OF THE
Corrugated Tube Feed Water Heaters,
Surface Condensers, Expansion Joints,
Expansion Tubes for Compound Engines,
Coil and Straight Tube, Vertical or Horizontal, Feed Water Heaters,
Harvard Pump Regulators,
Automatic Gauge Valves, Barnard's Separator.

F. B. ASPINWALL, 112 Liberty St., N. Y
H. S. WALKER, 26-28 W. Randolph St., Chicago.
RUSSELL & CO., St. Paul, Minn.
ST. LOUIS MECH. SUPPLY COMPANY, St. Louis and Kansas City, Mo.

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* MURRAY FLINT GLASS WORKS, *
Trenton Ave., Culvert and Waterloo Sts., PHILADELPHIA, PA.
MANUFACTURERS OF
Arc and Incandescent Globes and Shades of all shapes in Opal, Clear, Roughed and Colored.
Large Capacity. Prompt Shipments.

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THE PERKINS ELECTRIC LAMP CO.,
AGENTS FOR
Grimshaw White Core Wires, Cables and Tapes,
54 & 56 FRANKLIN ST., CHICAGO, ILL.
WRITE FOR PRICE LIST.

A PERFECT ARC LAMP FOR INCANDESCENT CIRCUITS.
THE CLARK ARC LIGHTING SYSTEM
THE CLARK ELECTRIC CO., CORBIN BUILDING. 192 BROADWAY, NEW YORK.

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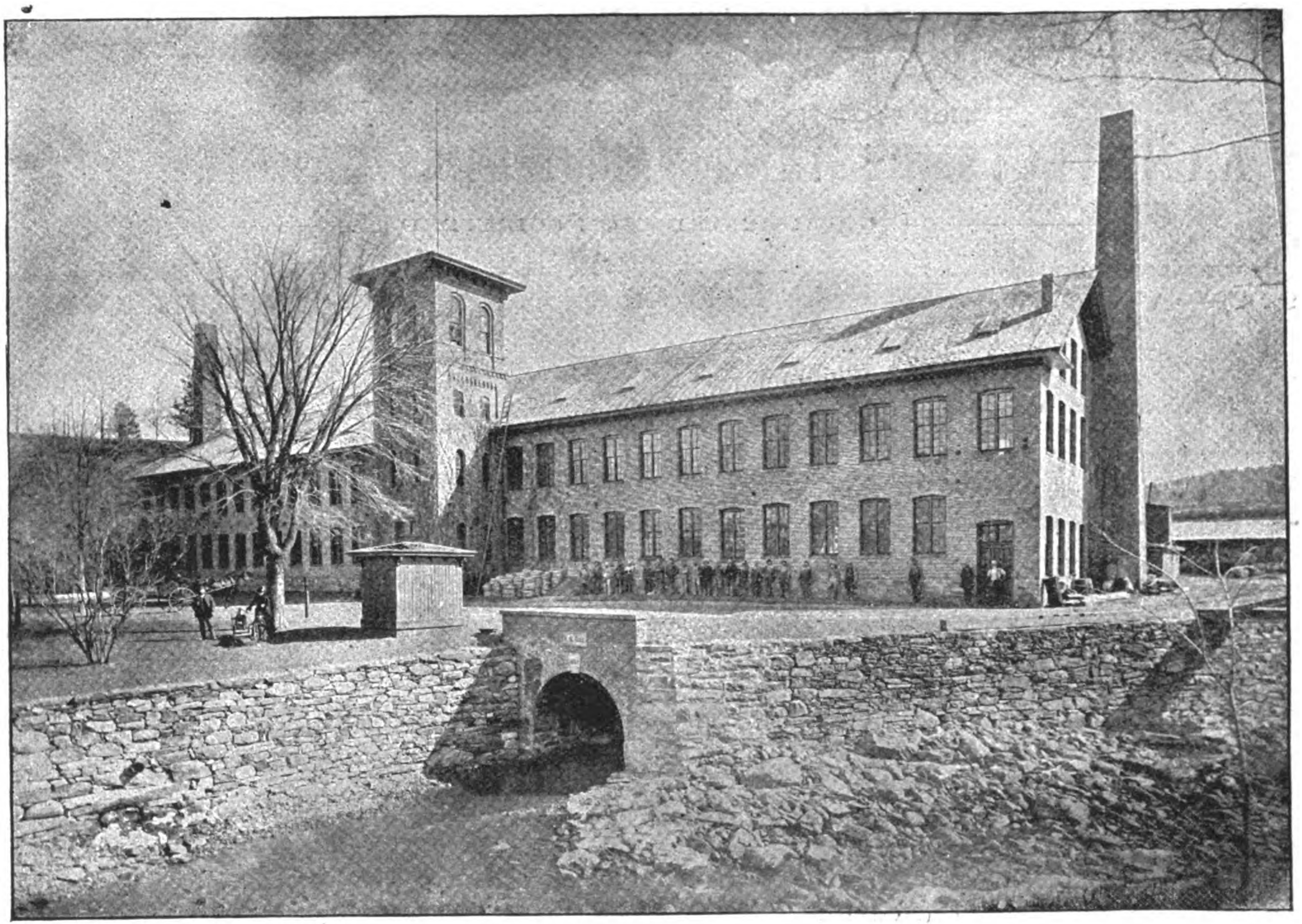

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Plain, Braided or Taped; Solid or Stranded Conductors for all Electrical Purposes.

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ARMORED SUBMARINE CABLES OUR SPECIALTY.

KERITE TAPE IN ROLLS OR SPOOLS. *ELASTIC RUBBER TAPE.*

SPECIAL QUOTATIONS ON LARGE ORDERS.

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AUTOMATIC ENGINE

(CENTRE CRANK),

With WHEEL GOVERNOR,

Giving Economy, Perfect Regulation of Speed, Simplicity and Rigidity of Parts.

These Engines have Single Flat Slide Valves, perfectly balanced with Cover Plate, so arranged that water may escape from cylinder without accident to Engine. We have adopted the **Straight Line Engine Co. Wheel Governor** as being the **most simple, perfect and powerful** Governor yet made, giving perfectly uniform speed under varying load and steam pressure.

We also make the **Porter Heavy Duty Engine, and a complete line of Portable and Stationary Engines and Boilers.**

☞ Write for full Descriptive Catalogues and Prices before buying.

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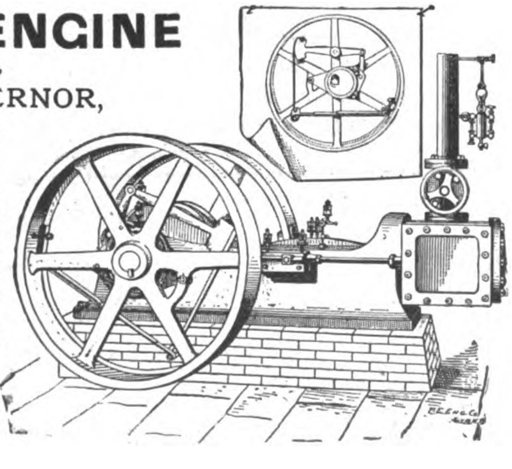

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Electric Light Installations

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MANAGEMENT OF ACCUMULATORS.

A PRACTICAL HAND-BOOK

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Member of Council of the Society of Telegraph Engineers and Electricians. Member of the American Institute of Electrical Engineers.

FIFTH EDITION, REVISED AND ENLARGED.

With 99 Illustrations.

D. VAN NOSTRAND COMPANY,

PUBLISHERS,

23 Murray and 27 Warren Sts.,

NEW YORK.

New Bedford, Mass.—The Union Street Railway Co. of New Bedford is making necessary repairs, previous to operating cars by electricity. No poles have been set yet. The work of laying the ground wire between the rails is progressing. Five new box cars fitted with motors have arrived. No open cars will be fitted with motors for the present.

Topeka, Kan.—General Manager Patten, of the Topeka Rapid Transit Railway, says: "An experience of twenty-five years with horses on roads in the East, and one year with electricity, leads me to believe that for a road having business sufficient for ten cars, electricity is far more economical, efficient and in every way superior to any other known motive power."

See further, page xix.

THE GETHINS IMPROVED GRAVITY BATTERY

ESPECIALLY ADAPTED FOR CLOSED CIRCUIT WORK.

MANUFACTURED BY

THE GETHINS ELECTRICAL MFG. COMPANY,

620 ATLANTIC AVE., BOSTON, MASS.

The Best Battery in the World for Fire Alarm, Police Signal, Railway Signal and Telegraph Work of all Kinds. Thousands of Batteries now in Use in all parts of the United States, and Giving Perfect Satisfaction.

ATTENTION IS CALLED TO THE FOLLOWING TESTIMONIAL:

POLICE DEPARTMENT OF THE CITY OF BOSTON,
SIGNAL SERVICE OFFICE,
(A) PEMBERTON SQ., April 17, 1890.

To the Honorable the Board of Police Commissioners:

GENTLEMEN:—I herewith report that the Gethins Gravity Batteries placed in Station 10, Jan. 17, 1889, were recharged with new elements of the same kind April 4, 1890, having shown a constant service of fourteen months, eighteen days. As the service of a battery is in proportion to the work done, I would state that during that time there were received 2,357 wagon signals, 12,237 telephone signals, and 198,486 "on duty" signals. As each signal will average ten breaks of the current this would indicate an armature movement of 2,131,160 times. As compared with the Standard Crowfoot battery, the best record in this service is seven months, twenty-three days.

Respectfully submitted,
(Signed) HENRY A. CHASE, Electrician.

PRICE LIST (subject to change).

Glass Jars	.80	Zincs	.85
Porous Cups	.50	Battery containing above parts	1.25
Coppers	.15		

Battery, without 6 x 8 glass jars, 1.00.

Discount to trade. All goods sold ex store, Boston, Mass.

Quantity of chemicals required for running battery 15 months:
Four pounds blue vitriol.
One ounce of sulphate of zinc.
Three ounces of mercury.

We can furnish above supplies if desired at market prices. The company is now prepared to furnish to parties desiring the same composition zincs at forty cents each. These zincs are a composition of zinc and mercury, and when used no mercury is required in setting up the battery, but this zinc should be occasionally amalgamated.

Send for our circulars.

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ELECTRIC

Transmission of Energy,

AND ITS

Transformation, Subdivision and Distribution,

A PRACTICAL HAND-BOOK,

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SECOND EDITION—348 Pages, Illustrated, 12mo, Cloth, postage prepaid to any address, $3.00.

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150 BROADWAY, NEW YORK.

UPPER AND LOWER

Carbon∴Holders

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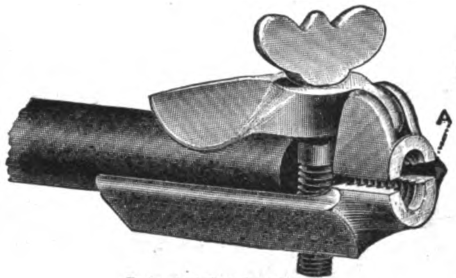
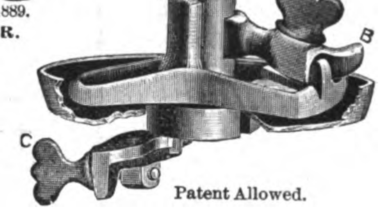


Patented October 1, 1889.
UPPER HOLDER.

☞ Porcelain Fuse Blocks guaranteed to prevent the fuse blowing from any cause except overload or short circuit. Very Cheap. Write for circular to



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Author of "The Dynamo," "Electric Instrument-making for Amateurs," Etc.

SECOND EDITION, REVISED.

D. VAN NOSTRAND COMPANY, Publishers,
23 Murray and 27 Warren Sts., New York.

FINANCIAL.

Van Wert, O.—The Citizen's Electric Light & Power Co. will increase its capital stock from $30,000 to $60,000.

FIRE ALARM.

Clinton, Ia. will probably establish an electric light plant.

ELECTRIC POWER.

Richmond, Va.—R. W. Taylor will start a factory to build electric motors.

FINANCIAL.

Gainesville, Ga.—The city of Gainesville, G. K. Looper, Mayor, will issue $40,000 of electric light bonds.

The Edison General Electric Co. has declared its third quarterly dividend of 2 per cent., payable July 3.

Charleston, S. C.—The Charleston Electric Light and Power Company has declared a dividend of 75 cents per share.

Americus, Ga.—The Americus Light and Power Company are offering $60,000 of 6 per cent. bonds through Thom & Whiteley, of Baltimore.

Boston, Mass.—The West End Street Railway Co. has declared a dividend of 4 per cent. on preferred and 5 per cent. on common stock, payable July 1.

NEW STREET RAILWAYS.

Lynchburg, Va.—The Elliott Farm Company proposes to build a street railway.

Americus, Ga.—The Americus Manufacturing and Improvement Company proposes to build a street railway.

Hamilton, Ont.—The capital stock of the Hamilton Electric Light Co. has been increased from $200,000 to $300,000.

Crosby ✦ Dry ✦ Battery

FOR OPEN CIRCUIT WORK.

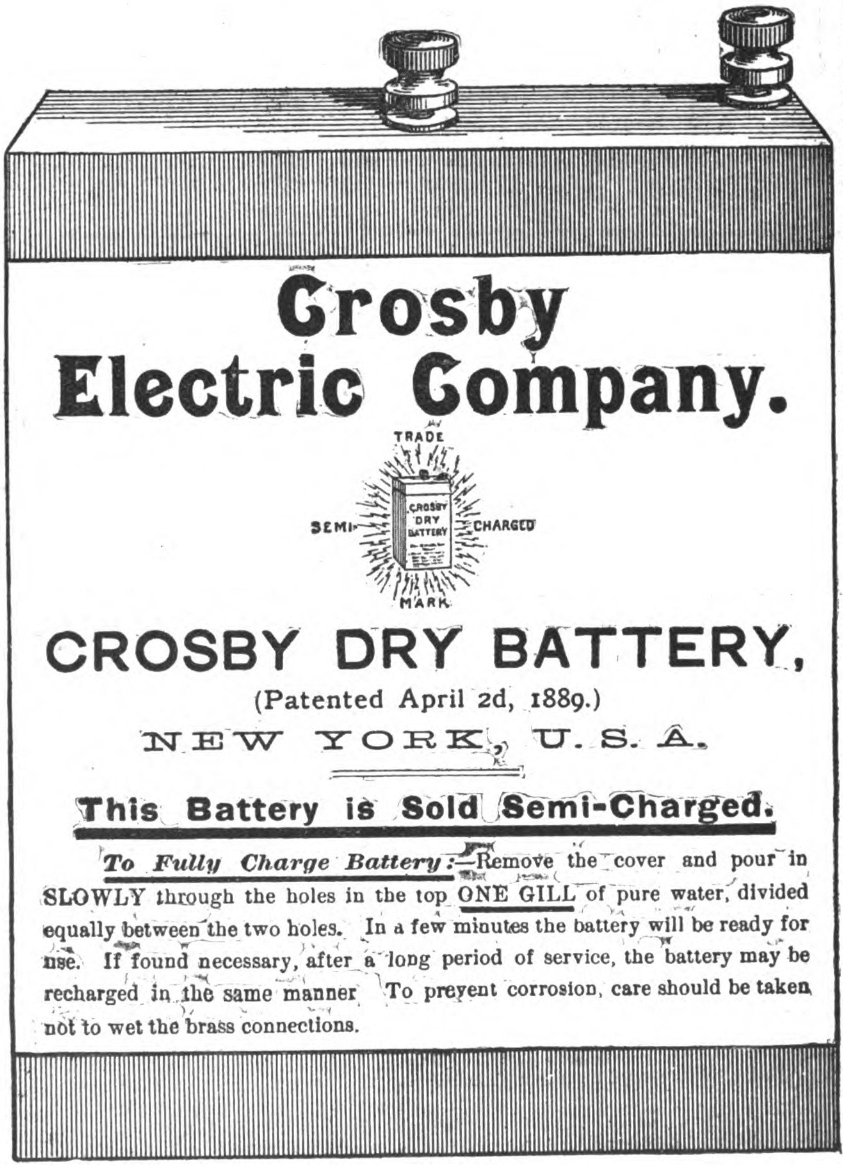
Electromotive Force, 1.55 Volts. **Current, 1 to 10 Amperes.**

Advantages of the Crosby Dry Battery for Open Circuit Work.

The Crosby Dry Battery is the **best Open Circuit Battery in the market.** It possesses all the advantages claimed for any Open Circuit Battery, and is capable of performing more work than any other. In addition to this, it is the **most reliable, most compact, most durable** and **simplest** cell yet discovered It is so constructed that **it is not destroyed** or seriously injured by **short circuiting,** and we are prepared to prove at any time that its **power of recuperation** is proportionately **greater** than that of any other. For Electric Bell, Gas Lighting, Burglar Alarms, Annunciators, Telephones, Microphones, Medical Electrical Purposes, Electrical Clocks and all the uses to which Open Circuit Batteries may be put. **It has no equal,** whether it be compared with **Liquid** or **other Dry Batteries.** We guarantee **depolarization, absence of offensive crystallization and perfect cleanliness.**

The Crosby Battery is the only Dry Battery sold **semi-charged. It does not work until wanted.**

The preference **as between Liquid and Dry Batteries** should always be given to the latter, provided the amount of working power required and a constant current can be obtained. **No form of Dry Battery has as yet been placed** before the public, except the **Crosby Dry Battery,** which will do the work of wet batteries and **give a constant supply of Electricity sufficient for reliable Open Circuit work at all times.** The advantages of a Dry Battery are obvious, because wet batteries, of whatever form, are constantly giving out offensive odors and spoiling everything with which their fumes come in contact. They are disagreeable and uncleanly machines, unsightly in appearance and easily broken and injured. **The Crosby Dry Battery is perfectly clean, emits no destructive gases or acids,** and, after once being properly connected, **requires no attention whatever,** while the liquid batteries are frequently in need of being cleaned, and the solution used must constantly be renewed.



CROSBY DRY BATTERY,
(Patented April 2d, 1889.)
NEW YORK, U. S. A.

This Battery is Sold Semi-Charged.

To Fully Charge Battery:—Remove the cover and pour in SLOWLY through the holes in the top ONE GILL of pure water, divided equally between the two holes. In a few minutes the battery will be ready for use. If found necessary, after a long period of service, the battery may be recharged in the same manner To prevent corrosion, care should be taken not to wet the brass connections.

The Crosby Battery is not affected by temperature; whether hot or cold, it is equally capable of performing the work for which it is intended.

The Crosby Dry Battery is only intended for **Open Circuit Work.** If, however, through an accident, it becomes **Short Circuited, it recoups itself.** This cannot be said with equal truth of any other dry battery known.

The Crosby Dry Batteries are manufactured in different sizes and forms, to suit the needs of different purchasers. The quantity of current required for any given work can be secured by a change in the form and size of the battery. For ringing bells and work of that character, the Cylindrical Batteries are to be preferred; but in instances where very low internal resistance is desired, as in telephone work and for medical electrical purposes, the Rectangular form is the better.

The quantity of current in the **Crosby Dry Batteries varies from one to ten amperes,** according to the size and shape, while the electromotive force remains constant at 1.55 volts

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OFFICE OF FLEMING'S ELECTRO-MEDICAL INSTRUMENT M'F'Y. No. 1009 Arch St., Philadelphia, March 8, 1890.

CROSBY ELECTRIC COMPANY, NEW YORK.—*Gentlemen:* The opportunity of expressing to you my views in reference to the Dry Cells made by your firm gives me great pleasure, and I do not hesitate in describing my experience with some of them. I charged and connected one of your No. 2 square cells with one of my rapidly interrupted 4-ohm resistance primary coils, starting it Jan. 28, 1890, at 4 P. M., kept running all night and following day, Jan. 29, when at 4 P. M. it became accidentally short-circuited, remaining so until 6 P. M. The cell was then released and allowed to recuperate till Jan. 30, 7.30 A. M., started again, **and left running until Feb. 13, stopping during night time. Thus, in defiance of a two-hour short circuit, this cell functioned = 371 consecutive hours, a result never before attained in all my experience with open circuit battery cells. The same cell, being recharged afterwards, still retains its working capacity, apparently as good as previous to its testing.**

Very respectfully,
(Signed), OTTO FLEMING.

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SIZES IN INCHES.

	Height.	Width.	Length.	Price.
Long Distance	7½	× 2½	× 4¾	$2.00
Telephone	7½	× 2	× 4¾	$1.50

CYLINDRICAL.

SIZE IN INCHES.

	Height.	Diam.
No. 3	7¼	× 2½

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SIZE IN INCHES.

	Height.	Width.	Length.
No. 2	5	× 1½	× 4½
No. 3	9	× 1½	× 8

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Electrical and Scientific Instruments of all Kinds, Blue Prints, Draughting, Patterns and Models.

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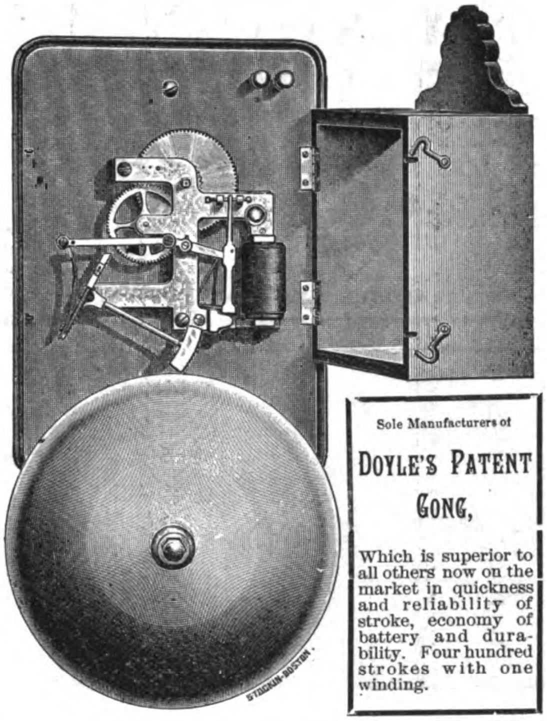

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DOYLE'S PATENT GONG,

Which is superior to all others now on the market in quickness and reliability of stroke, economy of battery and durability. Four hundred strokes with one winding.

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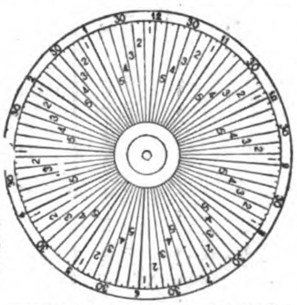

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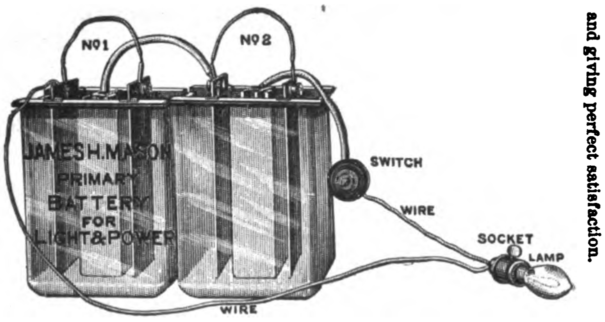

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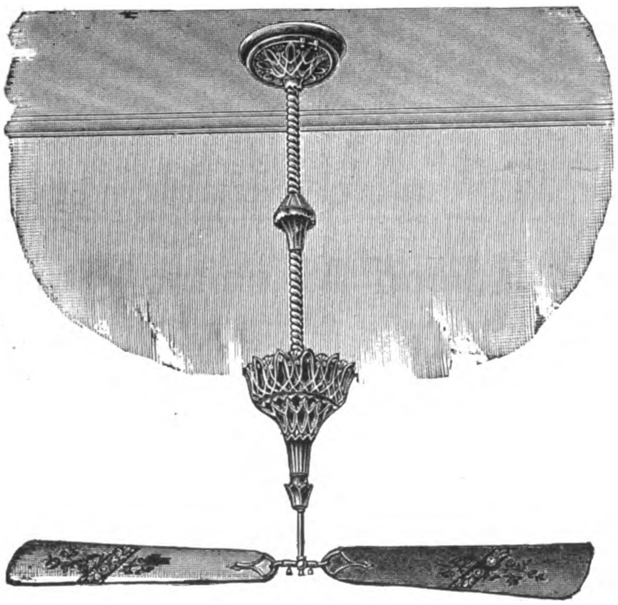
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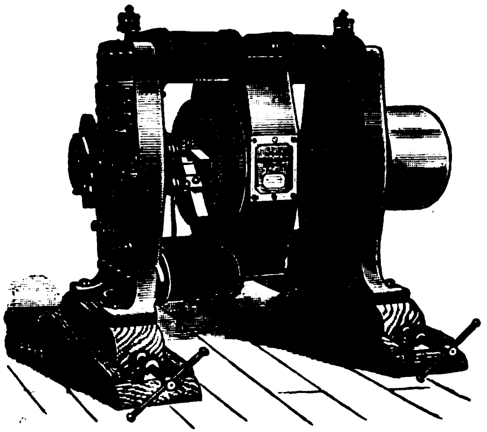

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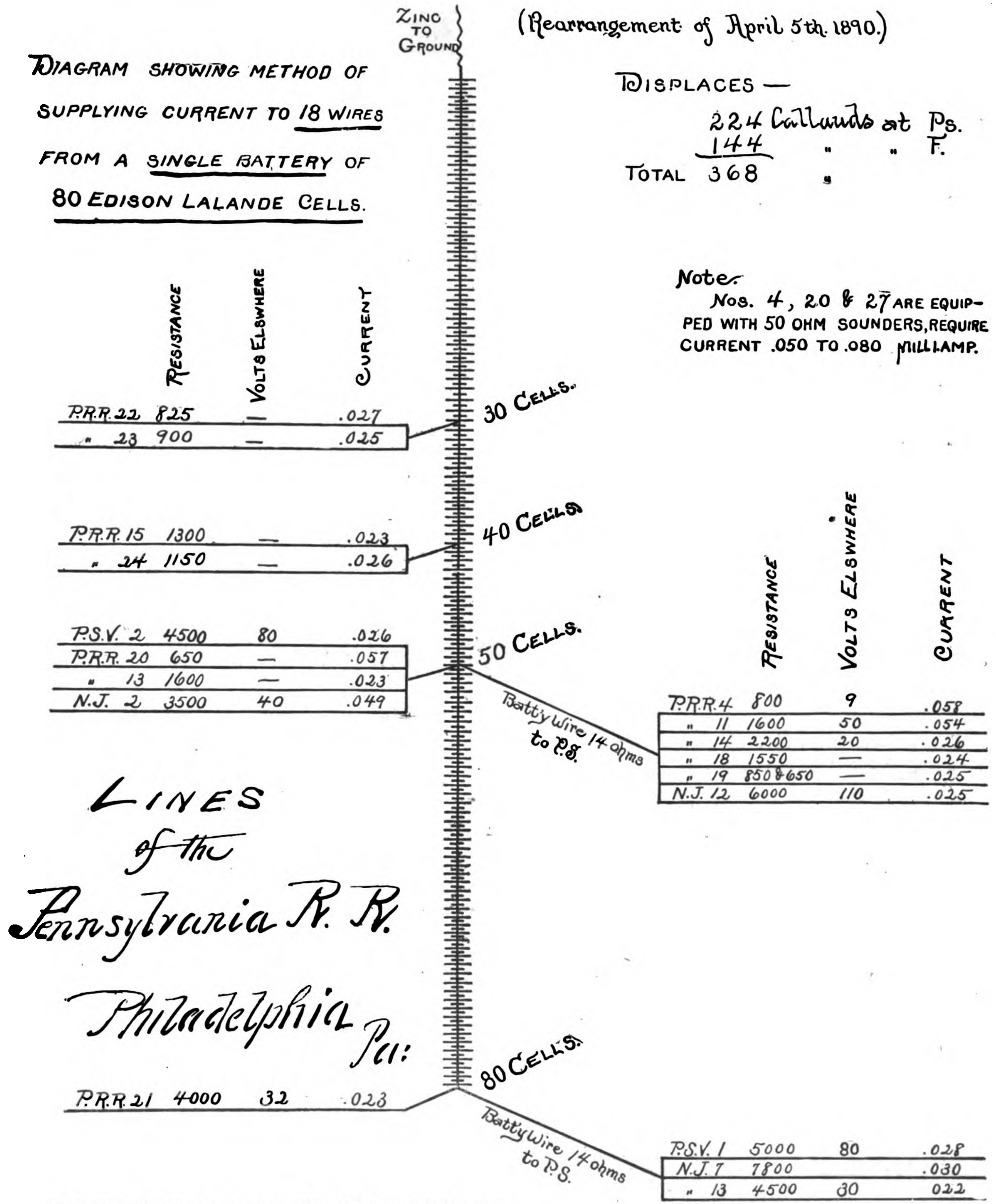

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P.R.R. 20	650	—	.057
" 13	1600	—	.023
N.J. 2	3500	40	.049

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P.R.R. 4	800	9	.058
" 11	1600	50	.054
" 14	2200	20	.026
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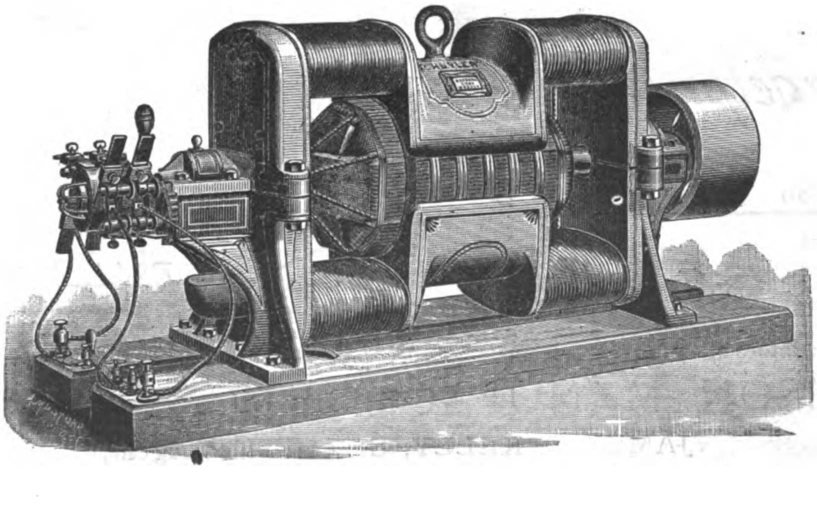

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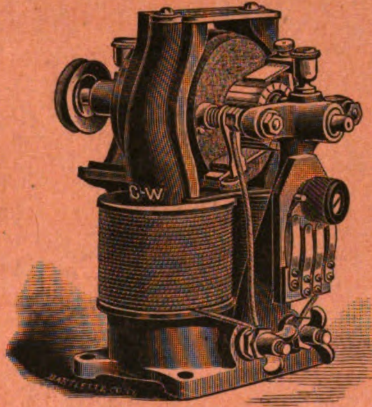

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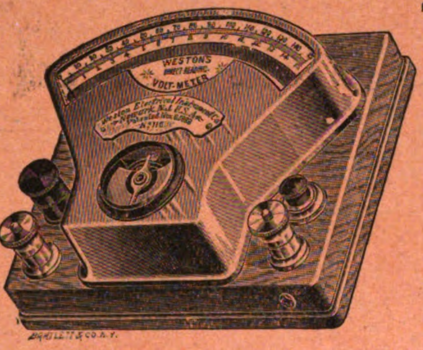

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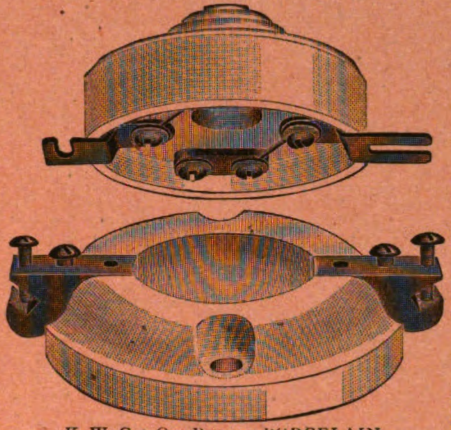

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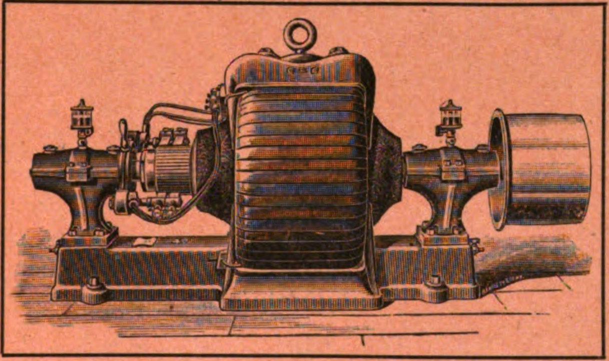

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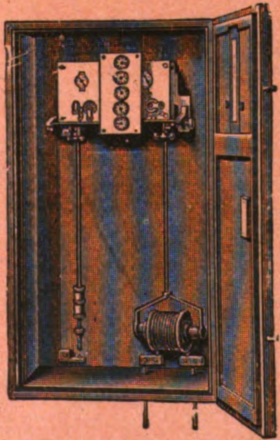

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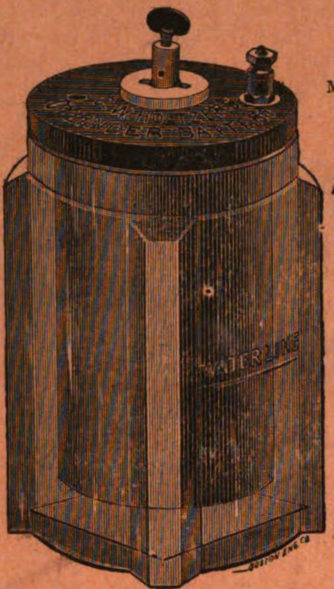

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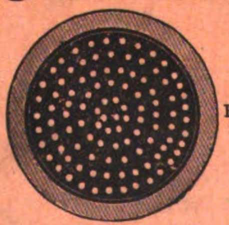

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